NatureCheck:

Understanding Wildlife Health on East Bay Lands in Alameda and Contra Costa Counties

Appendices

April 2022

TABLE OF CONTENTS

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APPENDIX A. ASSESSMENT TOOL FOR LANDS INCLUDED IN THIS ECOLOGICAL HEALTH ASSESSMENT

Because the land holdings of the Network partner agencies (California State Parks, Contra Costa Water District, East Bay Municipal Utility District, East Bay Regional Park District, and San Francisco Public Utilities Commission) are not contiguous, the agencies used ranking criteria to determine the NatureCheck area of focus. The initial ranking assessment was entitled *East Bay Ecological Health Assessment Area of Focus Methodology and Results Memorandum (AECOM 2018*). Subsequently, land unit names used in the ranking were modified to reflect current naming preferences and incorporate monitoring data and vegetation mapping groupings. Associated revisions to the number of land units evaluated were also made.

The purpose of this memorandum is to detail the methodology used to determine the area of focus. Lands owned or managed by East Bay Stewardship Network (Network) agencies are referred to as Network partner lands; additional agencies or land-management entities may be added to this group at a later date.

In order to determine which Network partner lands would be included in the area of focus, an evaluation tool was developed to objectively rate these lands based on their relative value to the NatureCheck. The relative value was based on nine criteria, which gauged specific land unit characteristics (e.g., proximity to other Network partner lands, vegetation communities present, and location within the Conservation Land Network's critical linkages dataset). The evaluation tool and associated criteria are provided in Table 1.

Several additional criteria were considered when developing the evaluation tool, including but not limited to the north/south gradient as it applies to climate change and elevation gradient. However, it was determined that these criteria did not provide sufficient additional refinement of lands to be included or excluded from the area of focus. Each of the nine criteria selected for inclusion in the evaluation tool were phrased as yes/no questions and given weighted scores[1] that were tallied to determine an overall rating for the Network partner land being evaluated. Instructions for using the evaluation tool were as follows:

[1] Criteria were weighted according to relative Network importance. The description of the criteria in Table 1 provides more information on the weighting

- Apply each criteria/question listed in Table 1 to an individual Network partner land unit under considered for inclusion in the area of focus.
- Circle the number (point value) associated with the respective responses (yes or no).
- Once all criteria have been applied/questions have been answered for an individual Network partner land unit, add the point values circled to create a point total/rating.

Following the development of the evaluation tool, Network agencies rated their own lands for inclusion within the area of focus. These ratings were compiled and are provided in Table 2. Network partner lands that received a rating of 11 or less were excluded from the area of focus; those that received a rating of 12 or greater were included. In summary, of the 84 Network partner lands evaluated, 61 were included in the area of focus and 23 were excluded. Network partner lands included within the area of focus are displayed in Figure 1. Excluded Network partner lands were primarily East Bay Regional Park District properties on or near the San Francisco Bay or delta shorelines. These properties are generally isolated from other Network partner lands and have dissimilar vegetation communities, making them less valuable to the NatureCheck in terms of cross-jurisdictional boundary collaboration and land management.

Table 1. Evaluation tool for assessing land units to be included in the NatureCheck area of focus

Criteria	Question	Response		Description of Criteria
		Yes	No	
Collaborative Lands	Is the land unit owned or managed by the Network partner agencies?	3	0	The ecological health assessment will succeed with continued participation and investment from the Network partner agencies. As such, inclusion of lands owned by East Bay Regional Park District, Contra Costa Water District, East Bay Municipal Utility District, San Francisco Public Utilities Commission, and California State Parks within the East Bay Area will be a primary factor in determining whether to include parcels within the area of focus.
Shared Property Boundaries	Does the land unit share a boundary with lands owned or managed by another Network partner agency?	3	0	One of the primary goals of the ecological health assessment is to promote the joint management of open space across jurisdictional boundaries. Network partner agencies with lands that share borders have high potential for joint management; including sharing resources, sharing resource management strategy, and solving common management challenges (e.g., invasive species).
Natural Lands	Is the land unit covered by 75 percent natural landscapes?	3	0	Natural lands are the focus of the East Bay ecological health assessment, rather than urbanized or developed (e.g., ballfields) lands.
Shared Plant Communities	Is the majority of the land unit covered by at least one of the following plant communities? Grassland Oak Woodland Chaparral Riparian Redwood Forest Coastal Scrub	3	0	Although health indicators have not been selected, common plant communities, including grassland, oak woodland, chaparral, coastal scrub, riparian, and redwood forest are likely to be indicators and/or can be used as a proxy for likely health indicators. Inclusion of land units based on shared plant communities/health indicators will create an area of focus where ecological health and health indicators can be measured equally across a landscape. The more homogenous the landscape, the more contained the effort required to develop and measure disparate health indicators, and the more feasible the development of the ecological health assessment will be overall.

Table 1. Evaluation tool for assessing land units to be included in the NatureCheck area of focus

Criteria	Question	Response		Description of Criteria
		Yes	No	
Connectivity to Natural Lands	Does this land unit contain or is this land unit located adjacent to a minimum of 500 acres of upland (non-tidal) natural lands or habitat-friendly agricultural lands?	3	0	Land units that are isolated by urban development are not as valuable for habitat connectivity, and opportunities for collaboration on isolated lands are limited. Please note: Roads and other linear infrastructure that traverse natural and agricultural lands are not counted against the size of the overall parcel or the continuity of the landscape for this criterion.
Watershed Boundaries (USGS HUC8)	Is this land unit located within a watershed where Network partner agency lands exist?	1	0	The ecological health of a given land unit is dependent upon the water that flows through it; and thus, the health of the watershed that contains it. Inclusion of only a portion of a watershed within an area of focus provides an incomplete picture of the greater landscape and the factors that contribute to the health of that landscape.
Bay Area Critical Linkages Dataset (published in 2010)	Is this land unit identified as being part of the Bay Area Critical Linkages dataset?	1	0	Habitat loss and fragmentation are the leading threats to biodiversity and countering these threats requires maintaining and restoring connections between existing natural areas. The Critical Linkages dataset identifies areas that are vital for connectivity to ensure the region is connected to the larger landscapes to the north and south. These linkage areas should be considered when developing the area of focus boundary.
Conservation Lands Network Landscape Units	Is the land unit located within one of the following Conservation Lands Network "landscape units"? North East Bay Hills Middle East Bay Hills South East Bay Hills North Contra Costa Valley Mt. Diablo Range Tri-Valley Mount Hamilton	1	0	The Conservation Lands Network Landscape Units capture the geographic division of the Bay Area and were developed to create spatially coherent units based on the physiographic features—such as mountain ranges and valley bottoms.
Controversial Lands	Is this land unit known to have a history of public controversy or existing/anticipated legal issues?	0	1	Controversial lands could demand an inequitable share of program resources. Legal battles and controversy could be detrimental to the overall vision of the program.
TOTAL:				Rating = Sum of the circled point values.

Table 2. Results of assessing land units based on the evaluation tool

Agency	Land Unit	Rating	Included in or Excluded from the Area of Focus	1. Network Partner Agency Lands	2. Shared Property Boundaries	3. Natural Lands	4. Shared Plant Communities	5. Connectivity to Natural Lands	6. Watershed Boundaries	7. Bay Area Critical Linkages	8. CLN Landscape Units	9. Controversial Lands
				Is the land unit owned or managed by the Network partner agencies?	Does the land unit share a boundary with lands owned or managed by another Network partner agency?	Is the land unit covered by 75 percent natural landscapes?	Is the majority of the land unit covered by one of, or combination of the following plant communities: Grassland, Oak Woodland, Chaparral, Riparian, Redwood Forest, or Coastal Scrub?	Does this land unit contain or is this land unit located adjacent to a minimum of 500 acres of non-tidal natural lands or habitat-friendly agricultural lands?	Is this land unit located within a watershed where Network partner agency lands exist? (Based on HUC 8 watershed units.)	Is this land unit identified as being part of the Bay Area Critical Linkages dataset?	Is the land unit located within one of the following Conservation Lands Network "landscape units": North East Bay Hills, Middle East Bay Hills, South East Bay Hills, North Contra Costa Valley, Mt. Diablo Range, Tri-Valley, or Mount Hamilton?	Is this land unit known to have a history of public controversy or existing/anticipated legal issues?
CCWD	Altamont Pass Habitat Management Unit[2]	15	Included	3	0	3	3	3	1	1	0	1
CCWD	Corral Hollow Habitat Management Unit	15	Included	3	0	3	3	3	1	1	0	1
CCWD	Los Vaqueros Reservoir	19	Included	3	3	3	3	3	1	1	1	1
CCWD	Marsh Creek Habitat Management Unit[3]	19	Included	3	3	3	3	3	1	1	1	1

[2] In certain cases, this land unit is sub-categorized into the Altamont Pass Road (AP-AP HMU or AP-AA HMU), Grant Line Road (AP-GL HMU), and Mountain House (AP-MH HMU) subunits.

[3] In certain cases, this land unit is sub-categorized into the Marsh Creek HMU–Deer Valley East (DVE) and Marsh Creek HMU–Deer Valley West (DVW).

CCWD	Morgan Territory Habitat Management Unit[4]	16	Included	3	0	3	3	3	1	1	1	1
CSP	Carnegie State Vehicular Recreation Area	15	Included	3	0	3	3	3	1	1	1	0
CSP	Franks Tract State Recreation Area	11	Excluded	3	0	3	0	3	1	0	0	1
CSP	Marsh Creek State Historic Park	19	Included	3	3	3	3	3	1	1	1	1
CSP	Mount Diablo State Park	19	Included	3	3	3	3	3	1	1	1	1
EBMUD	San Pablo/Briones Reservoirs[5]	18	Included	3	3	3	3	3	1	1	0	1
EBMUD	Lafayette Reservoir	15	Included	3	0	3	3	3	1	1	0	1
EBMUD	San Pablo Reservoir Recreation Area[6]	18	Included	3	3	3	3	3	1	1	0	1
EBMUD	Siesta Valley Recreation Area	18	Included	3	3	3	3	3	1	1	0	1
EBMUD	Upper San Leandro Reservoir[7]	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Anthony Chabot Regional Park	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Antioch/Oakley Regional Shoreline	5	Excluded	3	0	0	0	0	1	0	0	1
EBRPD	Ardenwood Historic Farm	5	Excluded	3	0	0	0	0	1	0	0	1
EBRPD	Bay Point Regional Shoreline	8	Excluded	3	0	3	0	0	1	0	0	1
EBRPD	Big Break Regional Shoreline	8	Excluded	3	0	3	0	0	1	0	0	1
EBRPD	Bishop Ranch Open Space Regional Preserve	16	Included	3	0	3	3	3	1	1	1	1
EBRPD	Black Diamond Mines Regional Preserve	16	Included	3	0	3	3	3	1	1	1	1
EBRPD	Briones Regional Park	19	Included	3	3	3	3	3	1	1	1	1

[4] In certain cases, this land unit is sub-categorized into the Morgan Territory HMU–MT North, Morgan Territory HMU–MT South, and Morgan Territory HMU–Storybook Ln.

[5] The area referred to as "EBMUD Pinole" is included in this land unit. More specifically, "EBMUD Pinole" refers to the Pinole Valley, which is the northern portion of this land unit. In certain cases, this entire land unit is also referred to as "San Pablo/Briones."

[6] In certain cases, this land unit is referred to as "EBMUD San Pablo."

[7] In certain cases, this land unit is referred to as "EBMUD San Leandro."

EBRPD	Brooks Island Regional Preserve	11	Excluded	3	0	3	3	0	1	0	0	1
EBRPD	Browns Island Regional Preserve	8	Excluded	3	0	3	0	0	1	0	0	1
EBRPD	Brushy Peak Regional Preserve	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Byron Vernal Pools Regional Preserve	16	Included	3	0	3	3	3	1	1	1	1
EBRPD	Carquinez Strait Regional Shoreline	15	Included	3	0	3	3	3	1	0	1	1
EBRPD	Castle Rock Regional Recreation Area	16	Included	3	3	0	3	3	1	1	1	1
EBRPD	Claremont Canyon Regional Preserve	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Clayton Ranch Regional Preserve	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Contra Loma Regional Park	16	Included	3	0	3	3	3	1	1	1	1
EBRPD	Coyote Hills Regional Park	11	Excluded	3	0	3	0	3	1	0	0	1
EBRPD	Crockett Hills Regional Park	15	Included	3	0	3	3	3	1	0	1	1
EBRPD	Cull Canyon Regional Recreation Area	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Deer Valley Regional Park	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Del Valle Regional Park	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Delta Access Regional Recreation Area	8	Excluded	3	3	0	0	0	1	0	0	1
EBRPD	Diablo Foothills Regional Park	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Don Castro Regional Recreation Area	10	Excluded	3	0	0	3	0	1	1	1	1
EBRPD	Dublin Hills Regional Park	16	Included	3	0	3	3	3	1	1	1	1
EBRPD	Five Canyons Open Space Regional Preserve	16	Included	3	0	3	3	3	1	1	1	1
EBRPD	Garin/Dry Creek Pioneer Regional Parks	16	Included	3	0	3	3	3	1	1	1	1
EBRPD	Hayward Regional Shoreline	8	Excluded	3	0	3	0	0	1	0	0	1
EBRPD	Huckleberry Botanic Regional Preserve	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Kennedy Grove Regional Recreation Area	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Lake Chabot Regional Park	19	Included	3	3	3	3	3	1	1	1	1

EBRPD	Las Trampas Wilderness Regional Preserve	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Leona Canyon Open Space Regional Preserve	13	Included	3	0	3	3	0	1	1	1	1
EBRPD	Little Hills Regional Recreation Area	16	Included	3	3	0	3	3	1	1	1	1
EBRPD	Martin Luther King Jr. Regional Shoreline	5	Excluded	3	0	0	0	0	1	0	0	1
EBRPD	McLaughlin Eastshore State Park	11	Excluded	3	0	3	3	0	1	0	0	1
EBRPD	Miller-Knox Regional Shoreline	11	Excluded	3	0	3	3	0	1	0	0	1
EBRPD	Mission Peak Regional Preserve	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Morgan Territory Regional Preserve	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	North Richmond Regional Shoreline	5	Excluded	3	0	0	0	0	1	0	0	1
EBRPD	Ohlone Wilderness Regional Preserve	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Oyster Bay Regional Shoreline	5	Excluded	3	0	0	0	0	1	0	0	1
EBRPD	Pleasanton Ridge Regional Park	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Point Isabel Regional Shoreline	11	Excluded	3	0	3	3	0	1	0	0	1
EBRPD	Point Pinole Regional Shoreline	16	Included	3	0	3	3	5	1	0	0	1
EBRPD	Quarry Lakes Regional Recreation Area	5	Excluded	3	0	0	0	0	1	0	0	1
EBRPD	Radke Martinez Regional Shoreline	8	Excluded	3	0	3	0	0	1	0	0	1
EBRPD	Rancho Pinole Regional Preserve	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Reinhardt Redwood Regional Park	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Robert Sibley Volcanic Regional Preserve	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Robert W. Crown Memorial State Beach	5	Excluded	3	0	0	0	0	1	0	0	1
EBRPD	Roberts Regional Recreation Area	16	Included	3	3	0	3	3	1	1	1	1
EBRPD	Round Valley Regional Preserve	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Shadow Cliffs Regional Recreation Area	7	Excluded	3	0	0	0	0	1	1	1	1
EBRPD	Sobrante Ridge Botanic Regional Preserve	19	Included	3	3	3	3	3	1	1	1	1

EBRPD	Sunol Wilderness Regional Preserve	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Sycamore Valley Open Space Regional Preserve	15	Included	3	0	3	3	3	1	0	1	1
EBRPD	Temescal Regional Recreation Area	10	Excluded	3	0	0	3	0	1	1	1	1
EBRPD	Thurgood Marshall Regional Park (formerly Concord Hills)	16	Included	3	0	3	3	3	1	1	1	1
EBRPD	Tilden Regional Park	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Tilden Regional Park - Botanic Garden	16	Included	3	3	3	0	3	1	1	1	1
EBRPD	Tilden Regional Park - Tilden Nature Area	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Vargas Plateau Regional Park	16	Included	3	0	3	3	3	1	1	1	1
EBRPD	Vasco Caves Regional Preserve	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Vasco Hills Regional Preserve	19	Included	3	3	3	3	3	1	1	1	1
EBRPD	Waterbird Regional Preserve	9	Excluded	3	0	3	0	0	1	0	1	1
EBRPD	Wildcat Canyon Regional Park	18	Included	3	3	3	3	3	1	0	1	1
SFPUC	Alameda Creek Watershed Lands[8]	19	Included	3	3	3	3	3	1	1	1	1

[8] In certain cases, this land unit is subdivided into the San Antonio Reservoir and Calaveras Reservoir land units.

APPENDIX B. AREA OF FOCUS SPECIES LIST

*eBird allows entry of hybrids or identification of certain birds to genus level (e.g., greater and lesser yellowlegs).

**Index for Conservation Status

FE = Federally Endangered

FT = Federally Threatened

FP = CDFW Fully Protected

SCC = CDFW Species of Special Concern

SE = State Endangered

ST = State Threatened

Common Name	Scientific Name	Source	Conservation Status**
Fish			
Black Crappie	*Pomoxis nigromaculatus*	Network Data	
Bluegill	*Lepomis macrochirus*	Network Data	
California Roach	*Hesperoleucus symmetricus*	Network Data	
Common Carp	*Cyprinus carpio*	Network Data	
Goldfish	*Carassius auratus*	Network Data	
Green Sunfish	*Lepomis cyanellus*	Network Data	
Largemouth Bass	*Micropterus salmoides*	Network Data	
Mosquitofish	*Gambusia affinis*	Network Data	
Pacific Lamprey	*Entosphenus tridentatus*	Network Data	SSC
Pricky Sculpin	*Cottus asper*	Network Data	
Rainbow Trout	*Oncorhynchus mykiss*	Network Data	
Sacramento Perch	*Archoplites interruptus*	Network Data	SSC
Sacramento Pikeminnow	*Ptychocheilus grandis*	Network Data	
Sacramento Sucker	*Catostomus occidentalis*	Network Data	
Smallmouth Bass	*Micropterus dolomieu*	Network Data	
Steelhead	*Oncorhynchus mykiss irideus pop. 8*	Network Data	FT
Three-spine Stickleback	*Gasterosteus aculeatus*	Network Data	
Western Brook Lamprey	*Lampetra richardsonii*	Network Data	SSC
Amphibians			
Arboreal Salamander	*Aneides lugubris*	GBIF	
American Bullfrog	*Lithobates catesbeianus*	GBIF	

Common Name	Scientific Name	Source	Conservation Status**
California Newt	*Taricha torosa*	GBIF	
California Red-legged Frog	*Rana draytonii*	GBIF	FT, SSC
California Slender Salamander	*Batrachoseps attenuatus*	GBIF	
California Tiger Salamander	*Ambystoma californiense*	GBIF	FT, ST
Ensatina	*Ensatina eschscholtzii*	GBIF	
Foothill Yellow-legged Frog	*Rana boylii*	GBIF	SE, SCC
Rough-skinned Newt	*Taricha granulosa*	GBIF	
Sierran Tree Frog	*Pseudacris sierra*	GBIF	
Western Spadefoot	*Spea hammondii*	GBIF	
Western Toad	*Anaxyrus boreas*	GBIF	
Reptiles			
Alameda Whipsnake	*Masticophis lateralis euryxanthus*	GBIF	FT, ST
Aquatic Garter Snake	*Thamnophis atratus*	GBIF	
Blainville's Horned Lizard	*Phrynosoma blainvillii*	GBIF	SSC
California King Snake	*Lampropeltis californiae*	GBIF	
California Mountain Kingsnake	*Lampropeltis zonata*	GBIF	
Coast Night Snake	*Hypsiglena ochrorhynchus*	GBIF	
Common Garter Snake	*Thamnophis sirtalis*	GBIF	
Common Sagebrush Lizard	*Sceloporus graciosus*	GBIF	
Common Side-blotched Lizard	*Uta stansburiana*	GBIF	
Common Slider	*Trachemys scripta*	GBIF	
Gilbert's Skink	*Plestiodon gilberti*	GBIF	
Gopher Snake	*Pituophis catenifer*	GBIF	
Long-nosed Snake	*Rhinocheilus lecontei*	GBIF	
Mediterranean House Gecko	*Hemidactylus turcicus*	GBIF	
North American Racer	*Coluber constrictor*	GBIF	
Northern Alligator Lizard	*Elgaria coerulea*	GBIF	
Painted Turtle	*Chrysemys picta*	GBIF	
Ring-necked Snake	*Diadophis punctatus*	GBIF	
Rubber Boa	*Charina bottae*	GBIF	
Sharp-tailed Snake	*Contia tenuis*	GBIF	
Southern Alligator Lizard	*Elgaria multicarinata*	GBIF	
Spiny Softshell Turtle	*Apalone spinifera*	GBIF	
Western Black-headed Snake	*Tantilla planiceps*	GBIF	
Western Fence Lizard	*Sceloporus occidentalis*	GBIF	
Western Pond Turtle	*Actinemys marmorata*	GBIF	SSC
Western Rattlesnake	*Crotalus oreganus*	GBIF	

Common Name	Scientific Name	Source	Conservation Status**
Western Skink	*Plestiodon skiltonianus*	GBIF	
Western Terrestrial Garter Snake	*Thamnophis elegans*	GBIF	
Western Whiptail	*Aspidoscelis tigris*	GBIF	
Birds			
Acorn Woodpecker	*Melanerpes formicivorus*	eBird Data	
Allen's Hummingbird	*Selasphorus sasin*	eBird Data	
American Avocet	*Recurvirostra americana*	eBird Data	
American Bittern	*Botaurus lentiginosus*	eBird Data	
American Coot	*Fulica americana*	eBird Data	
American Crow	*Corvus brachyrhynchos*	eBird Data	
American Dipper	*Cinclus mexicanus*	eBird Data	
American Goldfinch	*Spinus tristis*	eBird Data	
American Kestrel	*Falco sparverius*	eBird Data	
American Pipit	*Anthus rubescens*	eBird Data	
American Redstart	*Setophaga ruticilla*	eBird Data	
American Robin	*Turdus migratorius*	eBird Data	
American White Pelican	*Pelecanus erythrorhynchos*	eBird Data	
American Wigeon	*Mareca americana*	eBird Data	
Anna's Hummingbird	*Calypte anna*	eBird Data	
Ash-throated Flycatcher	*Myiarchus cinerascens*	eBird Data	
Bald Eagle	*Haliaeetus leucocephalus*	eBird Data	SE, FP
Band-tailed Pigeon	*Patagioenas fasciata*	eBird Data	
Barn Owl	*Tyto alba*	eBird Data	
Barn Swallow	*Hirundo rustica*	eBird Data	
Barrow's Goldeneye	*Bucephala islandica*	eBird Data	SSC
Bell's Sparrow	*Artemisiospiza belli*	eBird Data	
Belted Kingfisher	*Megaceryle alcyon*	eBird Data	
Bewick's Wren	*Thryomanes bewickii*	eBird Data	
Black Phoebe	*Sayornis nigricans*	eBird Data	
Black Swift	*Cypseloides niger*	eBird Data	SSC
Black-and-white Warbler	*Mniotilta varia*	eBird Data	
Black-bellied Plover	*Pluvialis squatarola*	eBird Data	
Black-chinned Hummingbird	*Archilochus alexandri*	eBird Data	
Black-chinned Sparrow	*Spizella atrogularis*	eBird Data	
Black-crowned Night-Heron	*Nycticorax nycticorax*	eBird Data	
Black-headed Grosbeak	*Pheucticus melanocephalus*	eBird Data	
Black-necked Stilt	*Himantopus mexicanus*	eBird Data	
Black-throated Gray Warbler	*Setophaga nigrescens*	eBird Data	

Common Name	Scientific Name	Source	Conservation Status**
Blue Grosbeak	*Passerina caerulea*	eBird Data	
Blue-gray Gnatcatcher	*Polioptila caerulea*	eBird Data	
Blue-winged Teal	*Spatula discors*	eBird Data	
Bonaparte's Gull	*Chroicocephalus philadelphia*	eBird Data	
Brandt's Cormorant	*Urile penicillatus*	eBird Data	
Brewer's Blackbird	*Euphagus cyanocephalus*	eBird Data	
Brewer's Sparrow	*Spizella breweri*	eBird Data	SSC
Brown Creeper	*Certhia americana*	eBird Data	
Brown Pelican	*Pelecanus occidentalis*	eBird Data	
Brown-headed Cowbird	*Molothrus ater*	eBird Data	
Bufflehead	*Bucephala albeola*	eBird Data	
Bullock's Oriole	*Icterus bullockii*	eBird Data	
Burrowing Owl	*Athene cunicularia*	eBird Data	SSC
Bushtit	*Psaltriparus minimus*	eBird Data	
Cackling Goose	*Branta hutchinsii*	eBird Data	
Cackling/Canada Goose	*Branta hutchinsii/canadensis*	eBird Data	
California Gull	*Larus californicus*	eBird Data	
California Quail	*Callipepla californica*	eBird Data	
California Scrub-Jay	*Aphelocoma californica*	eBird Data	
California Thrasher	*Toxostoma redivivum*	eBird Data	
California Towhee	*Melozone crissalis*	eBird Data	
Calliope Hummingbird	*Selasphorus calliope*	eBird Data	
Canada Goose	*Branta canadensis*	eBird Data	
Canvasback	*Aythya valisineria*	eBird Data	
Canyon Wren	*Catherpes mexicanus*	eBird Data	
Caspian Tern	*Hydroprogne caspia*	eBird Data	
Cassin's Finch	*Haemorhous cassinii*	eBird Data	
Cassin's Kingbird	*Tyrannus vociferans*	eBird Data	
Cassin's Vireo	*Vireo cassinii*	eBird Data	
Cattle Egret	*Bubulcus ibis*	eBird Data	
Cedar Waxwing	*Bombycilla cedrorum*	eBird Data	
Chestnut-backed Chickadee	*Poecile rufescens*	eBird Data	
Chestnut-sided Warbler	*Setophaga pensylvanica*	eBird Data	
Chimney/Vaux's Swift*		eBird Data	
Chipping Sparrow	*Spizella passerina*	eBird Data	
Cinnamon Teal	*Spatula cyanoptera*	eBird Data	
Clark's Grebe	*Aechmophorus clarkii*	eBird Data	
Clay-colored Sparrow	*Spizella pallida*	eBird Data	

Common Name	Scientific Name	Source	Conservation Status**
Cliff Swallow	*Petrochelidon pyrrhonota*	eBird Data	
Common Gallinule	*Gallinula galeata*	eBird Data	
Common Goldeneye	*Bucephala clangula*	eBird Data	
Common Loon	*Gavia immer*	eBird Data	SSC
Common Merganser	*Mergus merganser*	eBird Data	
Common Poorwill	*Phalaenoptilus nuttallii*	eBird Data	
Common Raven	*Corvus corax*	eBird Data	
Common Tern	*Sterna hirundo*	eBird Data	
Common Yellowthroat	*Geothlypis trichas*	eBird Data	
Common/Barrow's Goldeneye*		eBird Data	
Cooper's Hawk	*Accipiter cooperii*	eBird Data	
Costa's Hummingbird	*Calypte costae*	eBird Data	
Dark-eyed Junco	*Junco hyemalis*	eBird Data	
Domestic x Canada Goose (hybrid)		eBird Data	
Double-crested Cormorant	*Nannopterum auritum*	eBird Data	
Downy Woodpecker	*Dryobates pubescens*	eBird Data	
Downy/Hairy Woodpecker		eBird Data	
Dunlin	*Calidris alpina*	eBird Data	
Dusky Flycatcher	*Empidonax oberholseri*	eBird Data	
Eared Grebe	*Podiceps nigricollis*	eBird Data	
Eurasian Collared-Dove	*Streptopelia decaocto*	eBird Data	
Eurasian Wigeon	*Mareca penelope*	eBird Data	
European Goldfinch	*Carduelis carduelis*	eBird Data	
European Starling	*Sturnus vulgaris*	eBird Data	
Evening Grosbeak	*Coccothraustes vespertinus*	eBird Data	
Ferruginous Hawk	*Buteo regalis*	eBird Data	
Forster's Tern	*Sterna forsteri*	eBird Data	
Fox Sparrow	*Passerella iliaca*	eBird Data	
Gadwall	*Mareca strepera*	eBird Data	
Gadwall x Mallard (hybrid)		eBird Data	
Glaucous Gull	*Larus hyperboreus*	eBird Data	
Glaucous-winged Gull	*Larus glaucescens*	eBird Data	
Golden Eagle	*Aquila chrysaetos*	eBird Data	FP
Golden*/Bald Eagle*		eBird Data	
Golden-crowned Kinglet	*Regulus satrapa*	eBird Data	
Golden-crowned Sparrow	*Zonotrichia atricapilla*	eBird Data	
Grasshopper Sparrow	*Ammodramus savannarum*	eBird Data	SSC

Common Name	Scientific Name	Source	Conservation Status**
Gray Flycatcher	*Empidonax wrightii*	eBird Data	
Graylag Goose (Domestic type)		eBird Data	
Great Blue Heron	*Ardea herodias*	eBird Data	
Great Egret	*Ardea alba*	eBird Data	
Great Horned Owl	*Bubo virginianus*	eBird Data	
Greater Roadrunner	*Geococcyx californianus*	eBird Data	
Greater Scaup	*Aythya marila*	eBird Data	
Greater White-fronted Goose	*Anser albifrons*	eBird Data	
Greater Yellowlegs	*Tringa melanoleuca*	eBird Data	
Greater/Lesser Scaup		eBird Data	
Greater/Lesser Yellowlegs		eBird Data	
Great-tailed Grackle	*Quiscalus mexicanus*	eBird Data	
Green Heron	*Butorides virescens*	eBird Data	
Green-tailed Towhee	*Pipilo chlorurus*	eBird Data	
Green-winged Teal	*Anas crecca*	eBird Data	
Hairy Woodpecker	*Dryobates villosus*	eBird Data	
Hammond's Flycatcher	*Empidonax hammondii*	eBird Data	
Harris's Sparrow	*Zonotrichia querula*	eBird Data	
Hermit Thrush	*Catharus guttatus*	eBird Data	
Hermit Warbler	*Setophaga occidentalis*	eBird Data	
Herring Gull	*Larus argentatus*	eBird Data	
Herring x Glaucous Gull (hybrid)		eBird Data	
Herring x Glaucous-winged Gull (hybrid)		eBird Data	
Hooded Merganser	*Lophodytes cucullatus*	eBird Data	
Hooded Oriole	*Icterus cucullatus*	eBird Data	
Hooded Warbler	*Setophaga citrina*	eBird Data	
Horned Grebe	*Podiceps auritus*	eBird Data	
Horned Lark	*Eremophila alpestris*	eBird Data	
Horned/Eared Grebe		eBird Data	
House Finch	*Haemorhous mexicanus*	eBird Data	
House Sparrow	*Passer domesticus*	eBird Data	
House Wren	*Troglodytes aedon*	eBird Data	
House/Purple Finch		eBird Data	
Hutton's Vireo	*Vireo huttoni*	eBird Data	
Iceland Gull	*Larus glaucoides*	eBird Data	
Indian Peafowl (Domestic type)		eBird Data	
Indigo Bunting	*Passerina cyanea*	eBird Data	

Common Name	Scientific Name	Source	Conservation Status**
Killdeer	*Charadrius vociferus*	eBird Data	
Lark Bunting	*Calamospiza melanocorys*	eBird Data	
Lark Sparrow	*Chondestes grammacus*	eBird Data	
Lawrence's Goldfinch	*Spinus lawrencei*	eBird Data	
Lazuli Bunting	*Passerina amoena*	eBird Data	
Lazuli x Indigo Bunting (hybrid)		eBird Data	
Least Sandpiper	*Calidris minutilla*	eBird Data	
Lesser Black-backed Gull	*Larus fuscus*	eBird Data	
Lesser Goldfinch	*Spinus psaltria*	eBird Data	
Lesser Scaup	*Aythya affinis*	eBird Data	
Lesser Yellowlegs	*Tringa flavipes*	eBird Data	
Lewis's Woodpecker	*Melanerpes lewis*	eBird Data	
Lincoln's Sparrow	*Melospiza lincolnii*	eBird Data	
Loggerhead Shrike	*Lanius ludovicianus*	eBird Data	SSC
Long-billed Curlew	*Numenius americanus*	eBird Data	
Long-billed Dowitcher	*Limnodromus scolopaceus*	eBird Data	
Long-eared Owl	*Asio otus*	eBird Data	SSC
Long-tailed Duck	*Clangula hyemalis*	eBird Data	
MacGillivray's Warbler	*Geothlypis tolmiei*	eBird Data	
Mallard	*Anas platyrhynchos*	eBird Data	
Mallard (Domestic type)		eBird Data	
Marbled Godwit	*Limosa fedoa*	eBird Data	
Marsh Wren	*Cistothorus palustris*	eBird Data	
Merlin	*Falco columbarius*	eBird Data	
Mew Gull (now Short-billed Gull)	*Larus canus*	eBird Data	
Mountain Bluebird	*Sialia currucoides*	eBird Data	
Mourning Dove	*Zenaida macroura*	eBird Data	
Muscovy Duck (Domestic type)	*Cairina moschata var. domestica*	eBird Data	
Mute Swan	*Cygnus olor*	eBird Data	
Nashville Warbler	*Leiothlypis ruficapilla*	eBird Data	
Northern Flicker	*Colaptes auratus*	eBird Data	
Northern Harrier	*Circus hudsonius*	eBird Data	SSC
Northern Mockingbird	*Mimus polyglottos*	eBird Data	
Northern Parula	*Setophaga americana*	eBird Data	
Northern Pintail	*Anas acuta*	eBird Data	
Northern Pygmy-Owl	*Glaucidium gnoma*	eBird Data	
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	eBird Data	
Northern Saw-whet Owl	*Aegolius acadicus*	eBird Data	

Common Name	Scientific Name	Source	Conservation Status**
Northern Shoveler	*Spatula clypeata*	eBird Data	
Northern Waterthrush	*Parkesia noveboracensis*	eBird Data	
Nuttall's Woodpecker	*Dryobates nuttallii*	eBird Data	
Oak Titmouse	*Baeolophus inornatus*	eBird Data	
Olive-sided Flycatcher	*Contopus cooperi*	eBird Data	SSC
Orange-crowned Warbler	*Leiothlypis celata*	eBird Data	
Osprey	*Pandion haliaetus*	eBird Data	
Pacific Loon	*Gavia pacifica*	eBird Data	
Pacific Wren	*Troglodytes pacificus*	eBird Data	
Pacific/Winter Wren	*Troglodytes pacificus/hiemalis*	eBird Data	
Pacific-slope Flycatcher	*Empidonax difficilis*	eBird Data	
Pacific-slope/Cordilleran Flycatcher (Western Flycatcher)		eBird Data	
Painted Redstart	*Myioborus pictus*	eBird Data	
Palm Warbler	*Setophaga palmarum*	eBird Data	
Pectoral Sandpiper	*Calidris melanotos*	eBird Data	
Pelagic Cormorant	*Urile pelagicus*	eBird Data	
Peregrine Falcon	*Falco peregrinus*	eBird Data	
Phainopepla	*Phainopepla nitens*	eBird Data	
Philadelphia/Warbling Vireo		eBird Data	
Pied-billed Grebe	*Podilymbus podiceps*	eBird Data	
Pileated Woodpecker	*Dryocopus pileatus*	eBird Data	
Pine Siskin	*Spinus pinus*	eBird Data	
Prairie Falcon	*Falco mexicanus*	eBird Data	
Purple Finch	*Haemorhous purpureus*	eBird Data	
Purple Martin	*Progne subis*	eBird Data	SSC
Pygmy Nuthatch	*Sitta pygmaea*	eBird Data	
Red Crossbill	*Loxia curvirostra*	eBird Data	
Red Knot	*Calidris canutus*	eBird Data	
Red-breasted Merganser	*Mergus serrator*	eBird Data	
Red-breasted Nuthatch	*Sitta canadensis*	eBird Data	
Red-breasted Sapsucker	*Sphyrapicus ruber*	eBird Data	
Redhead	*Aythya americana*	eBird Data	SSC
Red-naped Sapsucker	*Sphyrapicus nuchalis*	eBird Data	
Red-naped x Red-breasted Sapsucker* (hybrid)		eBird Data	
Red-necked Grebe	*Podiceps grisegena*	eBird Data	
Red-necked Phalarope	*Phalaropus lobatus*	eBird Data	

Common Name	Scientific Name	Source	Conservation Status**
Red-shouldered Hawk	*Buteo lineatus*	eBird Data	
Red-tailed Hawk	*Buteo jamaicensis*	eBird Data	
Red-throated Loon	*Gavia stellata*	eBird Data	
Red-winged Blackbird	*Agelaius phoeniceus*	eBird Data	
Red-winged/Tricolored Blackbird*		eBird Data	
Ring-billed Gull	*Larus delawarensis*	eBird Data	
Ring-necked Duck	*Aythya collaris*	eBird Data	
Ring-necked Pheasant	*Phasianus colchicus*	eBird Data	
Rock Pigeon	*Columba livia*	eBird Data	
Rock Wren	*Salpinctes obsoletus*	eBird Data	
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	eBird Data	
Rose-breasted/Black-headed Grosbeak		eBird Data	
Ross's Goose	*Anser rossii*	eBird Data	
Rough-legged Hawk	*Buteo lagopus*	eBird Data	
Ruby-crowned Kinglet	*Corthylio calendula*	eBird Data	
Ruddy Duck	*Oxyura jamaicensis*	eBird Data	
Rufous Hummingbird	*Selasphorus rufus*	eBird Data	
Rufous*/Allen's Hummingbird		eBird Data	
Rufous-crowned Sparrow	*Aimophila ruficeps*	eBird Data	
Sage Thrasher	*Oreoscoptes montanus*	eBird Data	
Sandhill Crane	*Antigone canadensis*	eBird Data	
Savannah Sparrow	*Passerculus sandwichensis*	eBird Data	
Say's Phoebe	*Sayornis saya*	eBird Data	
Semipalmated Plover	*Charadrius semipalmatus*	eBird Data	
Sharp-shinned Hawk	*Accipiter striatus*	eBird Data	
Sharp-shinned*/Cooper's Hawk*		eBird Data	
Short-billed Dowitcher	*Limnodromus griseus*	eBird Data	
Short-billed/Long-billed Dowitcher		eBird Data	
Short-eared Owl	*Asio flammeus*	eBird Data	SSC
Snow Goose	*Anser caerulescens*	eBird Data	
Snow/Ross's Goose	*Anser caerulescens/rossii*	eBird Data	
Snowy Egret	*Egretta thula*	eBird Data	
Snowy Plover	*Charadrius nivosus*	eBird Data	
Solitary Sandpiper	*Tringa solitaria*	eBird Data	
Song Sparrow	*Melospiza melodia*	eBird Data	
Sora	*Porzana carolina*	eBird Data	

Common Name	Scientific Name	Source	Conservation Status**
Spotted Sandpiper	*Actitis macularius*	eBird Data	
Spotted Towhee	*Pipilo maculatus*	eBird Data	
Steller's Jay	*Cyanocitta stelleri*	eBird Data	
Summer Tanager	*Piranga rubra*	eBird Data	SSC
Surf Scoter	*Melanitta perspicillata*	eBird Data	
Swainson's Hawk	*Buteo swainsoni*	eBird Data	ST
Swainson's Thrush	*Catharus ustulatus*	eBird Data	
Swamp Sparrow	*Melospiza georgiana*	eBird Data	
Swan Goose (Domestic type)		eBird Data	
Townsend's Solitaire	*Myadestes townsendi*	eBird Data	
Townsend's Warbler	*Setophaga townsendi*	eBird Data	
Townsend's x Hermit Warbler (hybrid)		eBird Data	
Townsend's/Hermit Warbler		eBird Data	
Tree Swallow	*Tachycineta bicolor*	eBird Data	
Tree/Violet-green Swallow		eBird Data	
Tricolored Blackbird	*Agelaius tricolor*	eBird Data	ST, SCC
Tundra Swan	*Cygnus columbianus*	eBird Data	
Turkey Vulture	*Cathartes aura*	eBird Data	
Varied Thrush	*Ixoreus naevius*	eBird Data	
Vaux's Swift	*Chaetura vauxi*	eBird Data	SSC
Vesper Sparrow	*Pooecetes gramineus*	eBird Data	
Violet-green Swallow	*Tachycineta thalassina*	eBird Data	
Virginia Rail	*Rallus limicola*	eBird Data	
Warbling Vireo	*Vireo gilvus*	eBird Data	
Western Bluebird	*Sialia mexicana*	eBird Data	
Western Grebe	*Aechmophorus occidentalis*	eBird Data	
Western Gull	*Larus occidentalis*	eBird Data	
Western Kingbird	*Tyrannus verticalis*	eBird Data	
Western Meadowlark	*Sturnella neglecta*	eBird Data	
Western Sandpiper	*Calidris mauri*	eBird Data	
Western Screech-Owl	*Megascops kennicottii*	eBird Data	
Western Tanager	*Piranga ludoviciana*	eBird Data	
Western Wood-Pewee	*Contopus sordidulus*	eBird Data	
Western x Glaucous-winged Gull (hybrid)		eBird Data	
Western/Clark's Grebe		eBird Data	
Whimbrel	*Numenius phaeopus*	eBird Data	
White-breasted Nuthatch	*Sitta carolinensis*	eBird Data	

Common Name	Scientific Name	Source	Conservation Status**
White-crowned Sparrow	*Zonotrichia leucophrys*	eBird Data	
White-crowned x Golden-crowned Sparrow (hybrid)		eBird Data	
White-faced Ibis	*Plegadis chihi*	eBird Data	
White-tailed Kite	*Elanus leucurus*	eBird Data	FP
White-throated Sparrow	*Zonotrichia albicollis*	eBird Data	
White-throated Swift	*Aeronautes saxatalis*	eBird Data	
Wild Turkey	*Meleagris gallopavo*	eBird Data	
Willet	*Tringa semipalmata*	eBird Data	
Williamson's Sapsucker	*Sphyrapicus thyroideus*	eBird Data	
Willow Flycatcher	*Empidonax traillii*	eBird Data	SE
Wilson's Phalarope	*Phalaropus tricolor*	eBird Data	
Wilson's Snipe	*Gallinago delicata*	eBird Data	
Wilson's Warbler	*Cardellina pusilla*	eBird Data	
Wood Duck	*Aix sponsa*	eBird Data	
Wrentit	*Chamaea fasciata*	eBird Data	
Yellow Warbler	*Setophaga petechia*	eBird Data	SSC
Yellow-bellied Sapsucker	*Sphyrapicus varius*	eBird Data	
Yellow-bellied/Red-naped Sapsucker		eBird Data	
Yellow-billed Magpie	*Pica nuttalli*	eBird Data	
Yellow-breasted Chat	*Icteria virens*	eBird Data	
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	eBird Data	SSC
Yellow-rumped Warbler	*Setophaga coronata*	eBird Data	
Mammals			
American Badger	*Taxidea taxus*	GBIF	SSC
American Beaver	*Castor canadensis*	GBIF	
Big Brown Bat	*Eptesicus fuscus*	EBRPD	
Black Rat	*Rattus rattus*	GBIF	
Black-tailed Jackrabbit	*Lepus californicus*	GBIF	
Bobcat	*Lynx rufus*	GBIF	
Botta's Pocket Gopher	*Thomomys bottae*	GBIF	
Broad-footed Mole	*Scapanus latimanus*	GBIF	
Brown Rat	*Rattus norvegicus*	GBIF	
Brush Mouse	*Peromyscus boylii*	GBIF	
Brush Rabbit	*Sylvilagus bachmani*	GBIF	
California Ground Squirrel	*Otospermophilus beecheyi*	GBIF	
California Meadow Vole	*Microtus californicus*	GBIF	

Common Name	Scientific Name	Source	Conservation Status**
California Myotis	*Myotis californicus*	EBRPD	
California Pocket Mouse	*Chaetodipus californicus*	GBIF	
California Vole	*Microtus californicus*	GBIF	
Canyon Bat	*Parastrellus hesperus*	EBRPD	
Common Raccoon	*Procyon lotor*	GBIF	
Coyote	*Canis latrans*	GBIF	
Deer Mouse	*Peromyscus maniculatus*	GBIF	
Desert Cottontail	*Sylvilagus audubonii*	GBIF	
Domestic Cat	*Felis catus*	GBIF	
Eastern Gray Squirrel	*Sciurus carolinensis*	GBIF	
Elk	*Cervus elaphus*	GBIF	
European Rabbit	*Oryctolagus cuniculus*	GBIF	
Fox Squirrel	*Sciurus niger*	GBIF	
Gray Fox	*Urocyon cinereoargenteus*	GBIF	
Heerman's Kangaroo Rat	*Dipodomys heermanni*	EBMUD	
Hoary Bat	*Lasiurus cinereus*	EBRPD	
Horse	*Equus caballus*	GBIF	
House Mouse	*Mus musculus*	GBIF	
Long-tailed Weasel	*Mustela frenata*	2019 Vasco Road Study	
Mexican Free-tailed Bat	*Tadarida brasiliensis*	EBRPD	
Mountain Lion	*Puma concolor*	GBIF	
Mule Deer	*Odocoileus hemionus*	GBIF	
Muskrat	*Ondatra zibethicus*	GBIF	
Myotis	*Myotis spp.*	EBRPD	
North American River Otter	*Lontra canadensis*	GBIF	
Norwegian Rat	*Rattus norvegicus*	GBIF	
Pallid Bat	*Antrozous pallidus*	EBRPD	SSC
Pinyon Mouse	*Peromyscus truei*	GBIF	
Raccoon	*Procyon lotor*	GBIF	
Red Fox	*Vulpes vulpes*	GBIF	
San Francisco Dusky-footed Woodrat	*Neotoma fuscipes annectens*	GBIF	SSC
Silver-haired Bat	*Lasionycteris noctivagans*	EBRPD	
Spotted Skunk	*Spilogale putorius*	2019 Vasco Road Study	
Striped Skunk	*Mephitis mephitis*	GBIF	
Townsend's big-eared bat	*Corynorhinus townsendii*	EBRPD	SSC
Trowbridge's Shrew	*Sorex trowbridgii*	GBIF	

Common Name	Scientific Name	Source	Conservation Status**
Vagrant Shrew	*Sorex vagrans*	GBIF	
Virginia Opossum	*Didelphis virginiana*	GBIF	
Western Gray Squirrel	*Sciurus griseus*	GBIF	
Western Harvest Mouse	*Reithrodontomys megalotis*	GBIF	
Western Red Bat	*Lasiurus blossevillii*	EBRPD	SSC
Wild Boar	*Sus scrofa*	GBIF	
Yuma myotis	*Myotis yumanensis*	EBRPD	

APPENDIX C. NETWORK PARTNER SUPPORTING LANGUAGE

The following language that supports the purpose and goals of an ecological health assessment are excerpted below.

California State Parks (CSP)

- **Agency Mission:** To provide for the health, inspiration and education of the people of California by helping to preserve the state's extraordinary biological diversity, protecting its most valued natural and cultural resources, and creating opportunities for high-quality outdoor recreation.

- **Natural Resources Division (NRD) Mission:** NRD provides overall leadership and direction to the Department's natural resource responsibility: to acquire, protect, restore, maintain, and sustain outstanding and representative examples of California's natural and scenic values for the benefit of present and future generations.

- **Department Operations Manual 0300—Natural Resources Management, Monitoring:** Natural Resource health will be monitored to detect trends in baseline data and provide documentation of natural resource change to guide resource management.

Contra Costa Water District (CCWD)

- **Agency Mission:** The mission of the Contra Costa water District is to strategically provide a reliable supply of high-quality water at the lowest cost possible, in an environmentally responsible manner.

- **Agency Goal:** Practice environmental stewardship by protecting natural resources and minimizing environmental impacts.

- **Los Vaqueros Watershed Resource Management Goals:** Protect environmental, biological, and cultural resources. Promote educational, interpretive, and research programs within the Watershed. Conserve the tranquility, remoteness, and natural landscape of the Los Vaqueros watershed.

East Bay Municipal Utility District (EBMUD)

- **Agency Mission:** To manage the natural resources with which the District is entrusted; to provide reliable, high quality water and wastewater services at fair and reasonable rates for the people of the East Bay; and to preserve and protect the environment for future generations.

- **Biodiversity Management Program Goals:** Maintain and enhance biological resource values on District lands through active management, HCP compliance and careful coordination with other resource management programs.

  Biodiversity Management Program Objectives:

  1. Maintain, protect, enhance, and where feasible, restore plant and animal communities, populations, and species.

  2. Implement an ecosystem management approach that maintains, protects, and enhances natural ecological processes.

  3. Apply an adaptive management strategy using inventory, management, monitoring, and research.

  4. Coordinate all resource management programs to ensure that biological resources are protected.

East Bay Regional Park District (EBRPD)

- **Agency Mission:** The East Bay Regional Park District preserves a rich heritage of natural and cultural resources and provides open space, parks, trails, safe and healthful recreation, and environmental education. An environmental ethic guides the district in all of its activities.

- **East Bay Regional Park District Master Plan, 2013:**

  Resource Management Policy (1) : The District will maintain an active inventory of its resources and monitor their health and viability.

  Natural Resource Management Policy (1): The District will maintain, manage and conserve enhance and restore park wildland resources to protect essential plant and animal habitat within viable sustainable ecosystems.

  Natural Resource Management Policy (3): The District will manage park wildlands using modern resource management practices based on scientific principles supported by available research. New scientific information will be incorporated into the planning and implementation of District wildland management programs as it becomes available. The District will coordinate with other agencies and organizations in a concerted effort to inventory, evaluate and manage natural resources and to maintain and enhance the biodiversity of the region.

  Natural Resource Management Policy (9): The District will conserve and protect native animal species and enhance their habitats to maintain viable wildlife populations within balanced ecosystems. . . . The District will cooperate on a regular basis with other public and private land managers and recognized wildlife management experts to address wildlife management issues on a regional scale.

San Francisco Public Utilities Commission (SFPUC)

- **Agency Mission:** The SFPUC mission includes providing water in a manner that is inclusive of environmental interests and that sustains the resources entrusted to our care.
- **Strategic Plan:** The SFPUC's 2020 Strategic Plan includes an Environmental Stewardship Goal (sustainably manage our natural resources and physical systems to protect the people, water, land, and ecosystems that we affect).
- **Water Enterprise Environmental Stewardship Policy and the Alameda Watershed Management Plan:** The SFPUC Water Enterprise Stewardship policy states that the SFPUC will proactively manage the watersheds in a manner that maintains the integrity of the natural resources, restores habitats for native species, and enhances ecosystem function, commits the SFPUC to actively monitor the health of the terrestrial and aquatic habitats both under our ownership and affected by operations in order to continually improve ecosystem health, and refers to the use of relevant indicators for meeting these commitments.
- **2018 State of the Regional Water System Report:** The SFPUC Levels of Service (LOS) Goals and Objectives for the Water Enterprise refer to managing natural resources and physical systems to protect watershed ecosystems.
- **Alameda Watershed Management Plan Goals (Summarized):** To preserve and enhance the ecological resources of the watershed and to enhance public awareness of various watershed issues, including conservation. Policies and actions listed in under these goals include:

    1. Protecting and monitoring native wildlife and plant communities;
    2. Encouraging investigations of natural resources on the watershed for scientific research, education, and increasing the SFPUC's understanding of these resources and their condition;
    3. Conducting research and monitoring activities through collaborative and cooperative efforts with other agencies/groups whenever possible.
       Seek opportunities to develop mitigation banks or conservation areas on watershed lands, consistent with maintaining biodiversity and other resource values.

APPENDIX D. LIST OF ALL ECOLOGICAL HEALTH INDICATORS CONSIDERED

Proposed Indicator	Why Considered an Indicator of East Bay Ecological Health?	Included in This Report?	Data Availability
Vegetation Communities			
Grasslands	This vegetation community is the most widespread in the area of focus and among California's most altered ecosystems. Grasslands are critical for the majority of our rare and endangered species. Grasslands both support a wide diversity of pollinators and sequester carbons.	No	Currently, there are insufficient fine-scale vegetation data needed to inform metrics. This vegetation community will be included in the next NatureCheck report.
Riparian	Riparian areas provide critical habitat for specialized plant communities, macroinvertebrates, fish, and other wildlife.	No	Same as above
Shrubland/Chaparral	This vegetation community is highly adapted to California's Mediterranean climate and harbors many native and endemic plant and animal species.	No	Same as above
Oak woodland	Oak woodlands provide food, nutrients, shade, carbon storage, and water-quality protection. Invasive diseases, such as Sudden Oak Death, have had an impact on the health of this community.	No	Same as above
Redwood forests	The East Bay is one of five primary regions in the Bay Area with a natural distribution of coast redwoods. While limited in distribution within the area of focus, it is an iconic plant community, habitat for native species, and an important source of carbon sequestration.	No	Same as above
Seeps, springs, wet meadows	Wetlands provide flood control, water-quality enhancement, carbon sequestration, and essential breeding and foraging habitat for numerous fauna. They also support endemic and rare plant and animal species.	No	Same as above
Sycamore alluvial woodlands	This iconic native tree species is associated with riparian woodlands; the community provides breeding and	No	The community has a very limited range in the area of focus, limited data are

Proposed Indicator	Why Considered an Indicator of East Bay Ecological Health?	Included in This Report?	Data Availability
	foraging habitat for wildlife and is critical to recharging groundwater levels.		available, and the potential for hybridization make it a difficult indicator to evaluate.
Invertebrates			
Aquatic macroinvertebrates, pollinators, etc.	Insects are the basis of the global food chain and pollinators for critical food sources. Recent studies have documented that insect biomass is declining.	No	Currently, there are no known invertebrate inventories for the study area (included in data gaps/needs discussion).
Longhorn fairy shrimp *Branchinecta longiantenna*	These brachiopods are closely associated with vernal pools and rock ponds.	No	Only occurs within a small portion of the area of focus so therefore not a good indicator of overall ecological health.
Vernal pool fairy shrimp *Branchinecta lynchi*	These brachiopods are closely associated with vernal pools and rock ponds.	No	Only occurs within a small portion of the area of focus.
Vernal pool tadpole shrimp *Lepidurus packardi*	These brachiopods are closely associated with vernal pools and rock ponds.	No	Only occurs within a small portion of the area of focus.
Fishes			
Rainbow trout/Steelhead *Oncorhyncus mykiss*	This species is an indicator of stream and water-quality health as well as of connectivity between freshwater streams and the ocean.	Yes	Network partner agency data were sufficient to make an assessment of condition and trend for this species.
Fishes (overall)	Fish are an indicator of overall stream health and a food source for many species.	Yes	Network partner agency data on this indicator have been used to make an assessment of condition and trend.
Amphibians and Reptiles			
Alameda whipsnake *Masticophis lateralis euryxanthus*	A state and federally listed species that occupies primarily chaparral and rock outcroppings. It was once wide-ranging in Alameda and Contra Costa Counties, but its habitat is now severely limited and fragmented.	No	Species is cryptic, which makes it difficult to gather sufficient data and observe change over time. Presence of the species may be considered as a metric for chaparral habitat health.
California red-legged frog *Rana draytonii*	This species is an indicator of ponds and wetlands for breeding, and uplands for foraging and dispersal. It is a federally listed species.	Yes	Available data on this indicator have been used to make an assessment of condition and trend.
California tiger salamander *Ambystoma californiense*	This species, an indicator of ponds and wetlands suitability for breeding, is very dependent on upland grassland habitats, where it spends most of its adult life. It is a state and federally listed species.	Yes	Available data on this indicator have been used to make an assessment of condition and trend.

Proposed Indicator	Why Considered an Indicator of East Bay Ecological Health?	Included in This Report?	Data Availability
Foothill yellow-legged frog *Rana boylii*	The species is a good indicator of stream health; considered vulnerable to climate change.	No	Only occurs within a small portion of the area of focus.
Western pond turtle *Actinemys marmorata*	The species is an indicator of freshwater aquatic conditions, a California species of special concern; considered vulnerable to climate change.	Yes	Evaluated as part of amphibian and reptile diversity
Birds			
Birds (riparian, oak woodland, grassland and shrubland guilds)	Birds are recognized as indicators of ecological health across a spectrum of habitat types and plant communities, and provide numerous ecosystem services.	Yes	Available data on this indicator have been used to make an assessment of condition and trend.
California quail *Callipepla californica*	This species, which is native to and widespread in California, is a broad generalist; decreases in quail numbers across all habitats could indicate a broad ecological stressor.	No	There were insufficient data on this species to inform metrics. Other generalists (golden eagle) and evaluation of four bird guilds were used as indicators
Golden eagle *Aquila chrysaetos*	This species is a top predator that relies on grassland, shrubland, and mixed-forest habitats. It is abundant in the East Bay and susceptible to changing environmental conditions, such as drought.	Yes	Existing data on this indicator have been used to make an assessment of condition and trend.
Western burrowing owl *Athene cunicularia*	This species, a California species of special concern, is a good indicator of grassland ecosystems. Populations have experienced a marked decline in past decades.	No	There was insufficient data to inform metrics. Other suitable wildlife indicators of grassland habitats (e.g., the California tiger salamander and American badger) were included.
Mammals			
Bats (overall)	Bat presence indicates that the environment is providing necessary insect prey and roosting habitats (trees, snags, and rock outcrops).	Yes	Available data on bat species are limited. However, we were able to develop metrics and have used available data to make an assessment of condition and trend for rare and common bat species.
Dusky-footed woodrat *Neotoma fuscipes*	This species is an indicator of healthy, forested ecosystems and serves as important prey for upper trophic levels; its nests provide habitat for invertebrates and lizards.	Yes	Available data on this species is limited. However, we were able to develop metrics and have used available data to

Proposed Indicator	Why Considered an Indicator of East Bay Ecological Health?	Included in This Report?	Data Availability
			make an assessment of condition and trend.
California ground squirrel *Otospermophilus beecheyi*	The ground squirrel serves as an important food resource, and various taxa rely on its burrows for shelter. Since many taxa are dependent on and benefit from the ground squirrel, understanding its population health and monitoring it over time could help provide an early warning system regarding the effects of climate change on local populations.	Yes	Same as above
Puma *Puma concolor*	As a top carnivore, this large, charismatic species reveals a variety of information about habitat quality and connectivity, both locally and regionally.	Yes	Existing data on this indicator have been used to make an assessment of condition and trend.
Mesocarnivores	These species are indicators of ecosystem productivity and can be used as proxies for overall ecosystem stability and integrity.	Yes	Same as above
North American river otter *Lontra canadensis*	An aquatic system predator, this species has recently returned to the area of focus after having been extirpated for decades.	No	Very little data exist, although anecdotally, observations of this species are increasing.
San Joaquin kit fox *Vulpes macrotis mutica*	This species is federally endangered and state threatened. It is considered an indicator of grassland ecosystem health and relies on burrowing mammals for denning and prey.	No	While resources have gone into promoting the recovery of this species over the past several decades, it may be extirpated in the area of focus.
Abiotic Systems			
Hydrological systems	This broad indicator could include water quality, dissolved oxygen, stream flow, presence of invertebrates, and other factors associated with hydrofluvial geomorphic characteristics.	No	Draft metrics are being evaluated, but currently, data are insufficient to inform the metrics.

APPENDIX E. JANUARY 29–30, 2020, EAST BAY ECOLOGICAL HEALTH ASSESSMENT EXPERT WORKSHOPS ATTENDEES

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APPENDIX F. BIRDS CHAPTER SUPPLEMENTAL INFORMATION

EBIRD DATA AND HOW IT WAS USED

In Chapter 7 we discuss how we used eBird data to analyze trends across the 2010–2020 breeding seasons. We also discuss potential biases in the data. This Appendix provides additional information on the steps we took to control biases and how it resulted in data that is significantly different than that downloaded from the eBird data portal.

1. Even with rigorous quality control, there is general concern that—by virtue of being opportunistic and community-science sourced—eBird data may include errors and sampling bias. Specifically, Johnston et al. (2021) lists the following challenges with using eBird data:

   > *Firstly, the locations selected by participants to collect data are usually strongly spatially biased. For example, participants may preferentially visit locations that are close to where they live (Dennis and Thomas 2000, Mair and Ruete 2016), are more accessible (Botts et al. 2011, Kadmon et al. 2004), contain high species diversity (Hijmans et al. 2000, Tulloch et al. 2013), or are within protected areas (Tulloch et al. 2013). Secondly, the observation process is heterogeneous, with large variation in effort, time of day, observers, and weather, all of which can affect the detectability of species (Ellis and Taylor 2018, Hochachka et al. 2021, Oliveira et al. 2018.) Thirdly, participants often have preferences for certain species, which may lead to preferential recording of some species over others (Troudet et al. 2017, Tulloch and Szabo 2012).*

   Further, Johnston et al. (2020) acknowledge that “the number of CS [community science] projects has been growing exponentially.” Far less data was available in 2010 than in 2020, and caution should be exercised in comparing across multiple years. This is especially the case if the locations (and cover types) where birds were sampled appears to be changing through time.

   Consequently, we incorporated guidelines recommended by Johnson et al. for the use of eBird data. Specifically, spatial sampling to reduce spatial biases, including additional filters (such as effort) to standardize effort covariates and how observations were conducted. In addition, we also considered balancing the number of observations across years (as suggested by Fink et al. 2020).

2. eBird grew rapidly from its inception in 2002 to 2010. Our choice to only use 2010 and later data was dictated by the fact that by 2010, there was enough data in any one year to allow for a comparison across years.

3. Community scientists submit either incomplete or complete checklists of their observations to eBird. An incomplete checklist includes just one (or a few) species that an observer may have seen or heard (these are also called “incidental observations”), whereas a complete checklist includes all species noted by the observer. If observers only record individual species, nothing can be inferred about whether other species might have been at the location. However, if observers state that they recorded all species present—or a “complete checklist”—then the lack of a species at a site can be used to infer that the species was absent (although it could also have been undetected). Additionally, complete checklists often require that bird observers provide extra assurance of the quality of their data (e.g., that bird watching was their “primary activity” during the observation period). (Definitions for incidental observations and complete checklists can be found at https://support.ebird.org/en/support/solutions/articles/48000967748#anchorCompleteChecklists).

4. We downloaded all eBird observations (both incomplete and complete checklists) from 2010 to 2020 made within Network partner agency boundaries where a specific indicator species was present. With complete checklists, if our indicator species was not recorded, we could assume that the indicator species was absent. Note that because we included species-specific observations not included in complete checklists, there were slightly different datasets for each species. Also, we did not include hybrids or identifications to the genus or family level in presence/absence counts.

5. As discussed in the chapter, we considered only the breeding season, as the number of breeding birds is the most relevant metric of population sustainability.

6. We did not consider duplicate observations (those that occurred at the same location on the same day). eBird gives every unique combination of latitude and longitude a unique location ID. In a first pass, we used this to remove duplicate observations. In later data filtering (point 10), we imposed a grid and averaged across observations within a given grid cell on a given day. If there were multiple observations of species absence at the same location on the same day, we trimmed to a single absence. If there were multiple observations of varying species counts at the same location on the same day, we averaged the counts across observations and recorded a single observation for that location and day.

7. Approximately 95% of the data for each species came from complete checklists, which means that approximately 95% of observations were shared across species. Thus, the spatial location of points (Figure 7.1) and the land cover associated with those observations (Figure 7.2) is

largely shared across species. Because of this, we did not separately map each species and the land cover associated with observations of that species.

8. We considered only East Bay Stewardship Network (Network) partner lands. Exploring the surrounding areas, we found the following biases outside of agency boundaries:

    a. Initially, to incorporate as much data as possible, we considered the landscape surrounding agency boundaries and extending as far south as Gilroy. However, in this larger region, we found an increasing proportion of eBird observations through time in urban areas. Restricting our analyses to lands within Network partner agencies' boundaries allowed us to remove the increasing number of observations in urban areas through time. We also removed any observations from within Network partner agencies' boundaries where the land cover was designated as urban according to the Conservation Lands Network 2.0 (~5% of observations).

    b. Initially, to incorporate as much data as possible, we considered the landscape surrounding agency boundaries and extending as far south as Gilroy. In this larger extent, over time, an increasing proportion of the dataset came from the East Bay Hills subregion relative to areas south of Mount Hamilton outside the Network partner land agency boundaries. By eliminating the areas south of Mount Hamilton from the analysis, we no longer had to worry about the changing ratio of data. Still, within Network partner agency boundaries, there were more observations in the East Bay Hills region and a slightly higher ratio of data came from within the Mt. Hamilton region in 2010–2013, especially in 2012.

    c. The use of agency boundaries minimized the mismatch between the vegetation in which eBird observations occurred and the relative prevalence of that vegetation type within the landscape. Vegetation cover was provided by the Conservation Lands Network dataset. Within agency boundaries, oak woodland, and grassland were by far the most common vegetation type. If uniformly sampled, we might expect species affiliated with these cover types to be best described in the analyses.

    d. However, within and beyond agency boundaries, grasslands were relatively undersampled relative to their prevalence on the landscape (Figure 7.2), especially within the Mt. Diablo Range subregion. Undersampling could lead to too few observations of grassland species in any given year, which would make it hard to determine a trend across years. Thus, we have less confidence in the results for grassland species.

    e. On the other hand, oak woodlands were oversampled and therefore, there may be a relatively higher number of observations in which oak-associated species were recorded. Given that the degree of oversampling is not changing through time (compare the relative height of oak woodlands in 2010 compared to 2020 in Figure 7.2), oversampling is less of a concern because there would be enough observations across years to allow a trend analysis.

9. As mentioned, eBird observers are asked to record effort variables, specifically, the observation duration, distance travelled, and number of observers for every observation. Most (>95%) observers recorded effort variables, which makes these variables available for analysis. Effort is important because greater effort often leads to more species and individuals encountered, with the potential exception of very large numbers of observers (which might frighten birds away) or distance traveled (where very long distances may indicate cursory observation at each individual location).

   Additionally, we restricted our dataset to observations made within the breeding season (April 1–July 15) and during dawn, daylight, and dusk hours (5 a.m.–10 p.m.).

10. As discussed in the chapter, we imposed a grid on the landscape and averaged observations taken on the same day within each grid cell. We did this so that observations on a single popular day or in a single popular location would not overwhelm the data from other locations and days. We considered two grid resolutions—100 m (1 ha) and 200 m (4 ha)—reflecting species' territory size. If the maximum territory size for a species was less than 4 ha, we used the 100 m resolution; otherwise, we used the 200 m resolution.

    We used the 200 m grid cell resolution for the following species (see Tables 1–4 for scientific names): western meadowlark, horned lark, loggerhead shrike, downy woodpecker, oak titmouse, acorn woodpecker, California scrub-jay, white-breasted nuthatch, ash-throated flycatcher, and California thrasher. For all other species, we used the 100 m resolution. To our knowledge, there have been no rigorous tests of the importance of grid resolution versus territory size in regional eBird analyses. In using two territory sizes, our goal was a compromise between species-specific landscape grids and minimization of the probability that the same bird was observed in two locations on the same day.

11. The resulting maps—one for each year from 2010 to 2020—showed average counts within a grid cell across the breeding season. Additionally, we averaged effort variables: how far the observers traveled as they observed birds, how long the observers surveyed for birds, and the number of bird observers.

12. With these data-filtering rules in place, we analyzed two trends. As discussed in the chapter, the trends were intended to bracket two possible approaches to analysis:

    a. A conservative response variable (presence/absence) with an inclusive dataset that included all observations (incomplete and complete checklists) from 2010 to 2020.

b. A highly resolved response variable (observed abundance or counts) with a conservative dataset (only locations that had repeat observations).

13. In the presence/absence analysis, we included all locations with an eBird observation within Network partner agency land boundaries. Across years, different locations were sampled, which can introduce spatial heterogeneity and lead to highly variable abundance estimates in trend analyses. An example of an important heterogeneity might be that the sites sampled in 2012–2015 were mostly low-quality habitat sites, whereas the sites sampled in 2016–2020 were mostly high-quality habitat sites.

    To address this concern, in the final breeding-season-abundance map, we converted all abundance estimates to presence/absence. If the species was recorded in a grid cell at any point during the 66 days of the breeding season, the species was said to be present. This conversion prevented a few very high bird counts from affecting the abundance estimates. For each year, grid cell scores of 0 (absent) and 1 (present) were used in the analysis. The fraction of sites occupied (reported in Tables 5–8) is (number of presences)/[(number of absences) + (number of presences)].

    a. We ran a logistic regression to determine the probability of observing a species as a function of year and effort variables.

    b. Positive coefficients associated with year suggest increases in the probability of bird presence across the period 2010–2020. Negative coefficients suggest a decreasing likelihood of observing the indicator species.

    c. We also performed an analysis in which we subsampled the data to allow only 40 observations per year, then reran the logistic regression. Because each subsample of data created by taking 40 observations/year was different, we subsampled the data 1,000 times and ran a logistic regression on each of those 1,000 subsamples. We observed the histogram of year coefficients and p-values associated with those coefficients. The goal of this exercise was to confirm that the increasing number of observations from 2010 to 2020 did not influence trends. The results of this analysis did not suggest any substantial deviations in the outcome. Thus, we do not report the results of this subsampling exercise.

14. In the abundance analysis, we considered the number of individuals observed in the ~57 locations where there were eBird observations for a given species in at least eight of 11 years. The reported abundance is actually a density in individuals. For bird species with smaller territories (100 m grid cells) the units are birds per one hectare. For bird species with larger territories (200 m grid cells), the units on figures are birds per four hectares. In these locations, birds were sampled year after year within the eBird dataset to control for a spatial

heterogeneity that might influence abundance estimates. Average counts were rounded to integer values for count-based statistical models (either negative binomial or Poisson).

There was good agreement in abundance across years (y-axis in abundance figures in Tables 5–8) between the averaged counts and rounded counts as long as >10% of the observations reported a specific species. When approximately 10% of observations recorded a species presence, the rounded-count values sometimes showed a different pattern through time than the unrounded counts (unrounded counts are shown in Tables 5–8). Usually, the differences were due to averaged grid cells counts greater than zero but less than 0.5. When differences (between average and rounded counts) in abundance patterns through time emerged, we set averaged counts of 0.25–0.5 equal to one (in addition to averaged counts greater than 0.5). This modification usually caused the abundance patterns through time between averaged and rounded counts to converge. Species for which we employed this modification include the belted kingfisher, northern harrier, rufous-crowned sparrow, and yellow warbler.

a. We analyzed the trend in repeat observations across time using zero-inflated, standard Poisson regression or negative binomial mixed-effects models (whichever yielded the best fit), controlling for effort variables.

b. This analysis allowed us to introduce a random effect for observation location, which accounted for the fact that some of these locations (e.g., "birding hotspots") might have higher average counts than other locations. Comparisons in averaged and rounded counts across sites showed that rounding did not notably change the relative abundances across the ~57 locations introduced with the random effect.

15. We compared the output from these two trend analyses for a suite of birds within each vegetation type. Each species was assigned to one of three categories: increasing, unchanging, and declining.

16. For each species, we considered level of confidence in the trend data. Uncertainty could take many forms. For example, in the abundance analysis (described in point 14), a couple of high-abundance observations within a given year could lead to high overall abundance in that year despite being driven by one or a few observations. Alternatively, one year could be particularly high or low and drive trend patterns across years. Where such issues arise, we report them in the far-right column (Assessment) in Tables 5–8. We then provide an overall confidence ranking for each individual species. (Criteria for confidence assessments are described in Appendix C: Notes on Interpretation of Results.)

17. Considering all birds within specific vegetation types (riparian, grassland, oak woodland, and shrublands), we assigned health metrics to bird communities occurring within specific

ecosystems. Our determinations—"good," "caution," "significant concern," "unknown"—are listed in Appendix B: Species-specific Details, Summary Figures, Statistical Analyses.

18. We provided a confidence value for vegetation type based on confidence designations for individual species estimates as well as any additional concerns. For example, we had lower confidence when the vegetation type was undersampled compared to its representation within Network partner agency boundaries (i.e., grassland). As described in point 8c and 8d, we were less concerned with oversampling of a particular vegetation type (i.e., oak woodland).

19. We did not divide data based on subregions because we were concerned that there was not enough data from the Mt. Hamilton and Mt. Diablo subregions. For example, for the song sparrow, there are 13 repeat bird observations in the Mt. Diablo subregion, five repeat observations in the Mt. Hamilton subregion, and 39 repeat observations in the East Bay Hills subregion (there are small variations in the number of repeat locations across species; see point 7).

    Recall that in point 14, we say that we are less confident in our results when <10% of observations record a species present. If we assume that 10% of sites are occupied and we have roughly 50 repeat abundance observations in each year, then our abundance trends are based on five observations of abundance in each year. If we had a long time series (i.e. 1970–present), we could have very few observations in each year. However, with an 11-year time series and considerable potential sources of error in eBird data despite controlling for repeat locations (e.g., variation in observers and observation duration), we believe that at least three abundance locations are needed in each year. Thus, 30 repeat locations are needed for subregional analyses, especially for the less prevalent species. With fewer than 30 repeat observations, a single observation recording high abundance (lower limit in abundance is bounded at zero) can have a big impact on the results.

20. We found minimizing biases in the data across years to be important, similar to previous species distribution modeling work, which showed that the most accurate predictions occurred when the most rigorous data filtering techniques were employed (Johnston et al. 2021).

    To elaborate on this point, consider the question: Why not just download data summaries for Contra Costa and Alameda Counties across the years provided by eBird that were used in the Network's indicator worksheets? There are many answers to this question, including that those data are for all of Alameda and Contra Costa Counties (not only within Network partner agency boundaries). Further, the following are not accounted for:

a. The aforementioned bias of a large and increasing fraction of the data coming from urban areas.

b. A lack of overall control for cover type.

c. A lack of clarity on how the data are controlled for effort; the eBird website says that effort is controlled for in the average count, but we saw no mention of how this was done, and the summary statistic “number of birds/party-hour” does not count locations where a species was absent.

d. A lack of clarity about which observation types were used (i.e., incidental, historical, complete checklists).

e. Data that are not controlled for increasing observations through time.

f. Summaries that provide average abundance estimates (per observation) per week of year but do not provide any estimate of variation across observations.

In Figure 1, we plot the eBird summary data for the song sparrow. The error bars are the standard deviation in observations across weeks of the breeding season April 1 to July 15. The number of birds observed across a week is already an average, where an average across an average inherently has a lower standard deviation than an average across individual observations. Thus, the error bars are an underestimate of variability in eBird observations. However, they are instructive in that they are still quite high. Regardless, without a true metric of variation across abundance observations, statistical analyses on trends cannot be run.

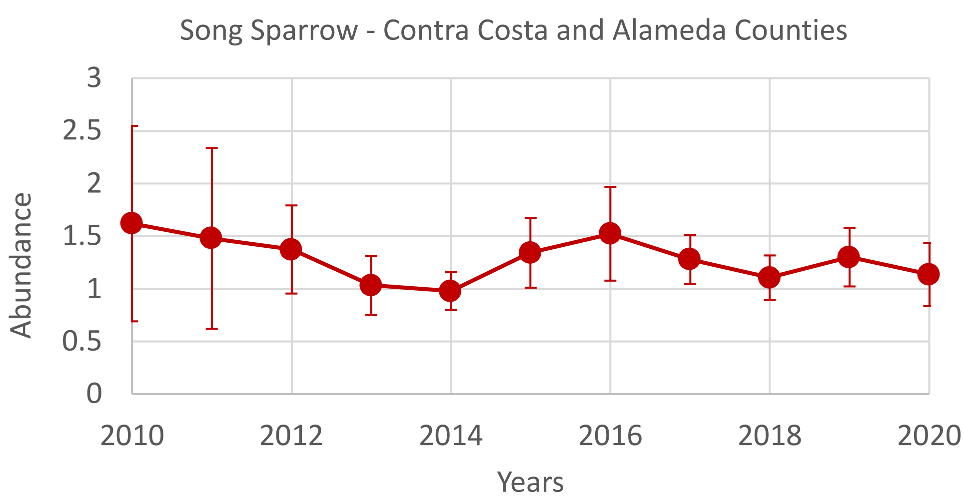


Figure 1. Average eBird data portal, song sparrow abundance summary across April 1–July 15 (breeding season) in the two counties. Error bars represent standard deviation across weekly average abundance.

In Figure 1, song sparrow abundance is quite stable from 2010 to 2020, especially given the variability in the data; high song sparrow counts in 2010 and 2011 are driven by one week of data on May 15 and 22, respectively, with nearly double the counts of any of the other weeks across all years (2010–2020). Because we downloaded a summary of eBird data, we have no additional information about why counts were so high in May 2010 and 2011. Overall, given these potential biases, we have less confidence in the trend seen in Figure 1.

SPECIES-SPECIFIC DETAILS, SUMMARY FIGURES, AND STATISTICAL ANALYSES

- Tables 1–4 provide additional species details.
- Tables 5–8 show summary figures and statistical analyses for each of the species we analyzed. Species are organized by vegetation association (defined as guilds in Chapter 7). A summary of individual species included within a vegetation type is provided prior to single-species results.
- We provide trend assessments for each of the two analyses mentioned in the previous section (see points 12–14). Single-species trends, condition, and confidence are defined in the chapter.
- We based vegetation-type trend, condition, and confidence on the combination of single-species results, as described in the chapter.

Table 1. Riparian indicator species: Conservation status, life-history traits, and vegetation associations.

Species	Conservation Status*	Migratory Status	Nest Substrate	Territory Size (ha)	Habitat and Vegetation Associations
Warbling vireo (*Vireo gilvus*)		Summer resident; migratory	Tree	1.2–1.5	Mature trees
Song sparrow (*Melospiza melodia*)		Resident	Herb, shrub	0.15–0.42	Dense understory
Black-headed grosbeak (*Pheucticus melanocephalus*)		Summer resident; migratory	Tree	0.43–3.9	Complex, with large trees and dense understory
Downy woodpecker (*Picoides* or *Dryobates pubescens*)		Resident	Tree, primary cavity	4.4–5.4	Dead trees and branches
Spotted towhee (*Pipilo maculatus*)		Resident	Ground		Dense understory and ground cover
Wilson's warbler (*Cardellina pusilla*)		Summer resident; migratory	Shrub	0.18–2.0	Dense understory
Belted kingfisher (*Megaceryle alcyon*)	BCC	Resident	Earthen banks, primary cavity		Streams, ponds with earthen banks
Tree swallow (*Tachycineta bicolor*)		Summer resident; migratory	Tree, secondary cavity		Woodland with adjacent open areas and water; dead trees
Yellow warbler (*Setophaga petechia*)	SSC	Summer resident; migratory	Shrub	0.14–1.03	Riparian thickets, esp. willows

Conservation status: *SSC = California bird species of special concern (Shuford and Gardali 2008), BCC = Birds of conservation concern (USFWS 2021). Sources for life-history information, *Birds of the World* (2020) and Shuford (1993).

Table 2. Grassland indicator species: Conservation status, life-history traits, and vegetation associations.

Species	Conservation Status*	Migratory Status	Nest Substrate	Territory Size (ha)	Habitat and Vegetation Associations
Savannah sparrow (*Passerculus sandwichensis*)		Resident	Ground	0.11–11.25	Dense ground layer (grasses, litter, scattered forbs)
Grasshopper sparrow (*Ammodramus savannarum*)	SSC, BCC	Summer resident; migratory	Ground	0.37–11.8	Tolerant of some shrub cover; may favor sloped landscapes over flat areas
Western meadowlark (*Sturnella neglecta*)		Resident	Ground	1.2–113	Grassland; will use trees for singing perches
Horned lark (*Eremophila alpestris*)		Resident	Ground	0.3–15.1	Open, low-stature grassland, and/or significant expanse of bare ground
Northern harrier (*Circus hudsonius*)	SSC, BCC	Resident	Ground, shrub		Forages over a variety of open landscapes; prefers to nest in shrubby or weedy fields
Loggerhead shrike (*Lanius ludovicianus*)	SSC	Resident	Shrub	3–16	Grassy oak savannah
White-tailed kite (*Elanus leucurus*)		Resident	Tree, tall shrub		Open, moist meadow; grassland; pasture

Conservation status: *SSC = California bird species of special concern (Shuford and Gardali 2008), BCC = Birds of conservation concern (USFWS 2021). Sources for life-history information, *Birds of the World* (2020) and Shuford (1993).

Table 3. Oak-woodland indicator species: Conservation status, life history traits, and vegetation associations.

Species	Conservation Status*	Migratory Status	Nest Substrate	Territory Size (ha)	Habitat and vegetation associations
Oak titmouse (*Baeolophus inornatus*)	BCC	Resident	Tree, secondary cavity	0.7–5.1	Open, dry woodland with open branchwork
Acorn woodpecker (*Melanerpes formicivorus*)		Resident	Tree, primary cavity	6	Mature, open oak savannah; dense woodland
California scrub-jay (*Aphelocoma californica*)		Resident	Tree, large shrubs	0.7–6.5	Open oak woodland; habitat edges; residential areas with trees
Lark sparrow (*Chondestes grammacus*)		Resident	Ground		Oak savannah, grassland/ woodland ecotones; requires trees for foraging and singing
Western bluebird (*Sialia mexicana*)		Resident	Tree, secondary cavity	0.29–0.79	Oak savannah, woodland; nests in tree cavities but often forages in open areas, grassland edges
White-breasted nuthatch (*Sitta carolinensis*)		Resident	Tree, secondary cavity	10–20	Open oak woodland; open branchwork
Ash-throated flycatcher (*Myiarchus cinerascens*)		Summer resident; migratory	Tree, secondary cavity	1–36	Mature, open woodland
Nuttall's woodpecker (*Picoides* or *Dryobates nuttallii*)	BCC	Resident	Tree, primary cavity		Mature woodland
Blue-gray gnatcatcher (*Polioptila caerulea*)		Summer resident; migratory	Tree, shrub		Oak woodland interfacing with chaparral or brushy openings

Conservation status: *SSC = California bird species of special concern (Shuford and Gardali 2008), BCC = Birds of conservation concern (USFWS 2021). Sources for life-history information, *Birds of the World* (2020) and Shuford (1993).

Table 4. Shrub/chaparral indicator species: Conservation status, life-history traits, and vegetation associations.

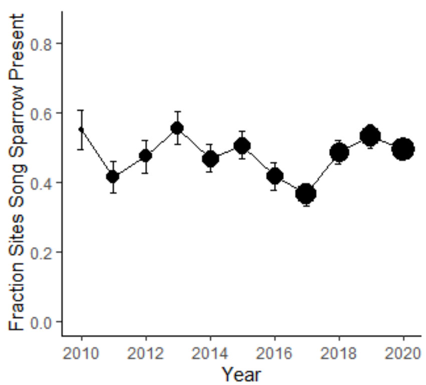
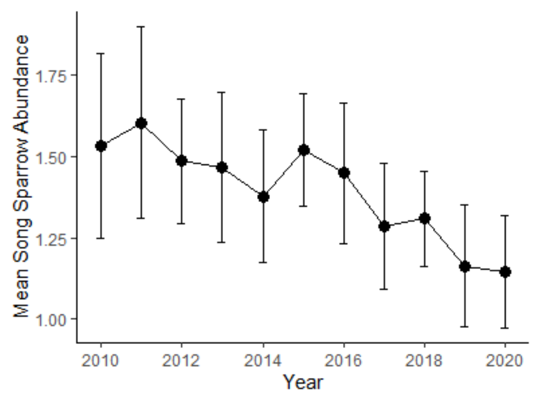
Species	Conservation Status*	Migratory Status	Nest Substrate	Territory Size (ha)	Habitat and vegetation associations
Wrentit (*Chamaea fasciata*)	BCC	Resident	Shrub		Dense, continuous shrub layer
California thrasher (*Toxostoma redivivum*)	BCC	Resident	Shrub	1.6–5	Dense chaparral; forages on loose, dry, bare ground
Rufous-crowned sparrow (*Aimophila ruficeps*)		Resident		1.5	Steep slopes with patchy shrub, short chaparral, frequently with rocky outcrops

Conservation status: *SSC = California bird species of special concern (Shuford and Gardali 2008), BCC = Birds of conservation concern (USFWS 2021). Sources for life-history information, *Birds of the World* (2020) and Shuford (1993).

Photographs of example indicator species: Top left, spotted towhee (riparian); top right, western meadowlark (grasslands); bottom left, California scrub-jay (oak woodland); bottom right, wrentit (shrub).

Photo credits: meadowlark, Susan Young; spotted towhee, Rick Clark.

Table 5. Single-species results for riparian species. Across species, the y-axis for the presence/absence figures has fixed limits (0 to 0.85) but the abundance figures have limits based on the observed abundance of the species. Significant trend coefficients are listed in bold followed by +/- and a second number; the second number is the standard error in the model coefficient. In the parenthetical for significant results are the test statistic, df (degrees of freedom), and the p-value for the test statistic. Error bars represent the standard error in presence/absence (figure, left) or abundance (figure, right).

RIPARIAN	To assess the health of riparian habitat, we analyzed trends in the song sparrow, warbling vireo, black-headed grosbeak, downy woodpecker, spotted towhee, Wilson's warbler, belted kingfisher, tree swallow, and yellow warbler. There were enough data to analyze all nine species, although the belted kingfisher and yellow warbler results should be viewed with some caution. Of the nine we analyzed, five were increasing, three were stable, and one showed some evidence of decline.		**Condition:** Caution **Trend:** Unchanging **Confidence:** High. Despite some uncertainty in individual species results, most species had similar trends and most species trends were known with confidence.
Species	**Trend – Presence/absence with all availability data**	**Trend – Abundance data from repeat observations**	**Assessment**
Song sparrow			**Condition:** Caution **Presence/absence trend:** Unchanging **Abundance trend:** Declining **Confidence:** High
	<u>Statistical Tests:</u> No significant trend was detected for the song sparrow.	<u>Statistical Tests:</u> Running a Poisson mixed-effects model (with no zero inflation), a significant declining trend was found ($z = -2.19$, $df = 1$, $p = 0.029$), with a coefficient for year of -**0.030 +/- 0.014**.	

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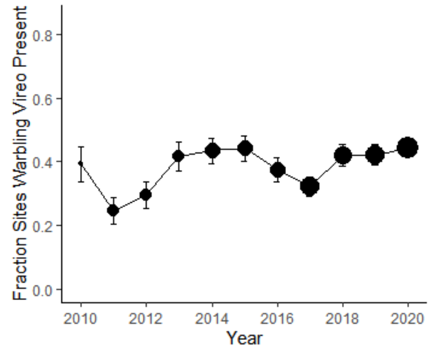
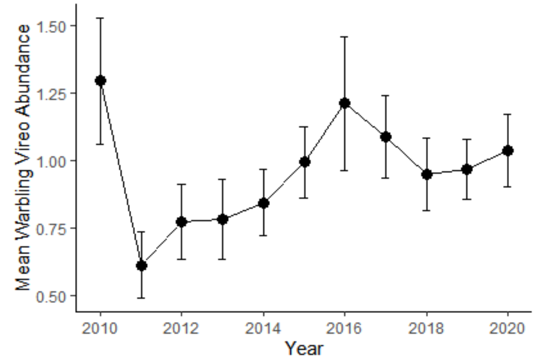
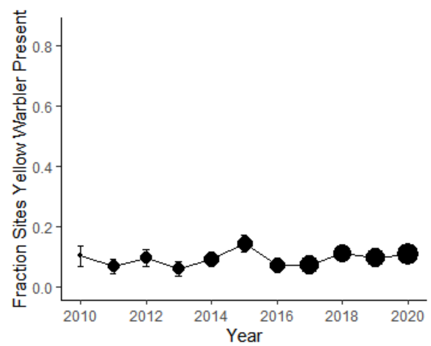
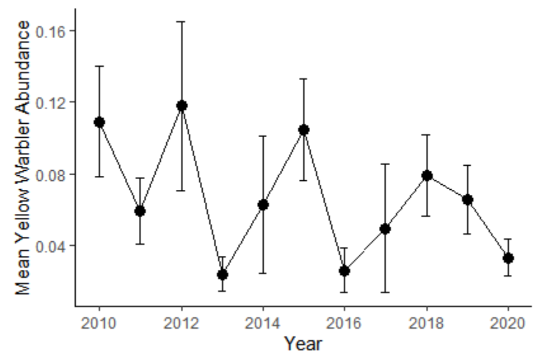
<tr>
<td rowspan="2">Warbling vireo</td>
<td></td>
<td></td>
<td rowspan="2">Condition: Good
Presence/absence trend: Improving
Abundance trend: Unchanging
Confidence: High</td>
</tr>
<tr>
<td><u>Statistical Tests:</u>
A significant positive trend was detected for the warbling vireo (z = 2.95, df = 1, p = 0.0032), with a coefficient for year of 0.051 +/- 0.017.</td>
<td><u>Statistical Tests:</u>
Running a Poisson mixed-effects model (with no zero inflation), a marginally significant increasing trend was found (z = 1.86, df = 1, p = 0.063), with a coefficient for year of 0.030 +/- 0.016.</td>
</tr>
<tr>
<td rowspan="2">Yellow warbler</td>
<td></td>
<td></td>
<td rowspan="2">Condition: Good
Presence/absence trend: Unchanging
Abundance trend: Unchanging
Confidence: Low. A small fraction of locations recorded the presence of yellow warblers (specifically, 7/11 years had <10% of observations where yellow warblers were present).</td>
</tr>
<tr>
<td><u>Statistical Tests:</u>
No significant trend was detected for the yellow warbler.</td>
<td><u>Statistical Tests:</u>
Running a Poisson mixed-effects model (no zero inflation), no significant effect of year was found.</td>
</tr>
</table>

<table>
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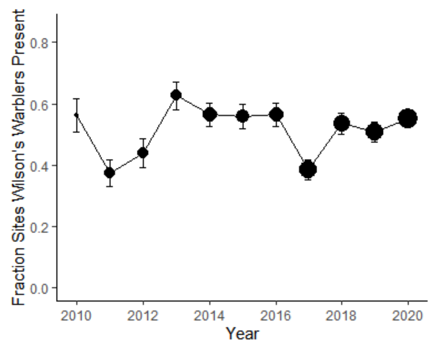
<td rowspan="2">Wilson’s warbler</td>
<td>
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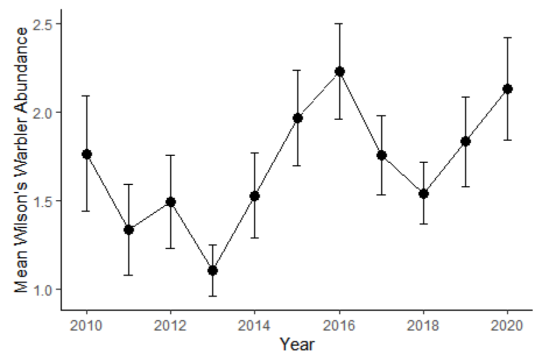
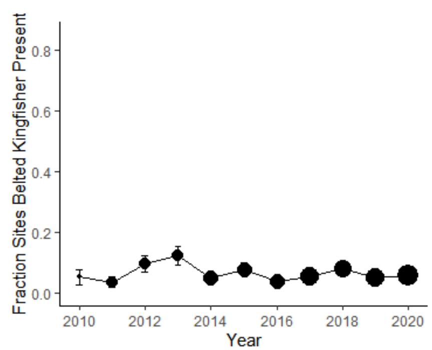
<td>
</td>
<td rowspan="2">Condition: Good
Presence/absence trend: Unchanging
Abundance trend: Improving
Confidence: High</td>
</tr>
<tr>
<td><u>Statistical Tests:</u>
No significant trend was detected for the Wilson’s warbler.</td>
<td><u>Statistical Tests:</u>
Running a Poisson mixed-effects model (no zero inflation), a significant increasing trend was found (z = 2.90, df = 1, p = 0.0037), with a coefficient for year of 0.035 +/- 0.012.</td>
</tr>
<tr>
<td rowspan="2">Belted kingfisher</td>
<td>
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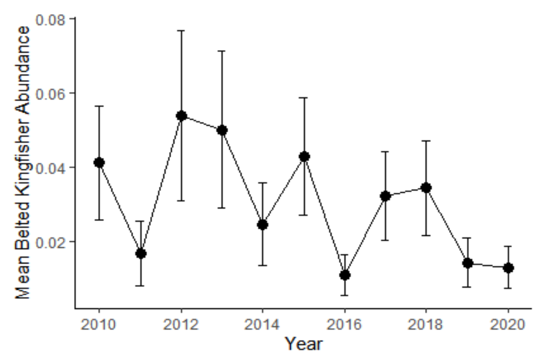
<td>
</td>
<td rowspan="2">Condition: Good
Presence/absence trend: Unchanging
Abundance trend: Unchanging
Confidence: Low. A small fraction of locations recorded the presence of belted kingfishers (specifically, 10/11 years had <10% of observations where belted kingfisher were present).
While the belted kingfisher appears to be declining, there are not enough observations that record species presence to make this trend significant.</td>
</tr>
<tr>
<td><u>Statistical Tests:</u>
No significant trend was detected for the belted kingfisher.</td>
<td><u>Statistical Tests:</u>
Running a negative binomial mixed-effects model (no zero inflation), no significant trend was found.</td>
</tr>
</table>

<table>
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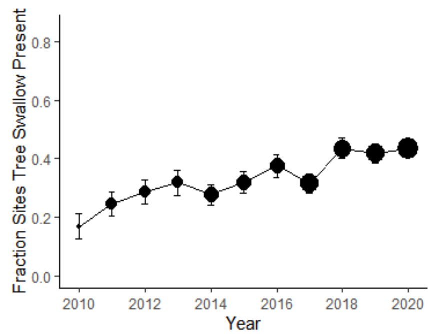
<td rowspan="2">Tree swallow</td>
<td>
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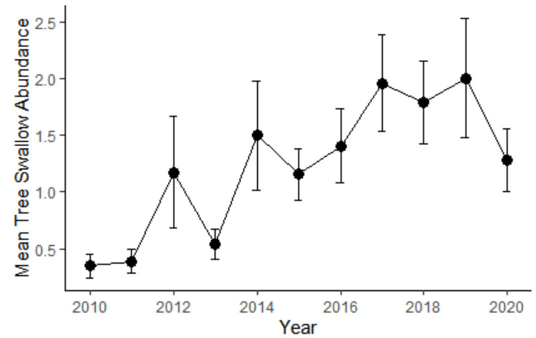
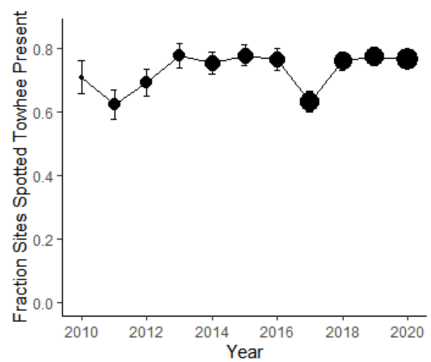
<td>
</td>
<td rowspan="2">Condition: Good
Presence/absence trend: Improving
Abundance trend: Improving
Confidence: High</td>
</tr>
<tr>
<td><u>Statistical Tests:</u>
A significant positive trend was detected for the tree swallow (z = 5.13, df = 1, $p < 10^{-6}$), with a coefficient for year of 0.092 +/- 0.018.</td>
<td><u>Statistical Tests:</u>
Running a negative binomial mixed-effects model with zero inflation (intercept and duration in minutes), a significant increasing trend was found (z = 5.69, df = 1, $p < 10^{-6}$), with a coefficient for year of 0.14 +/- 0.025.</td>
</tr>
<tr>
<td rowspan="2">Spotted towhee</td>
<td>
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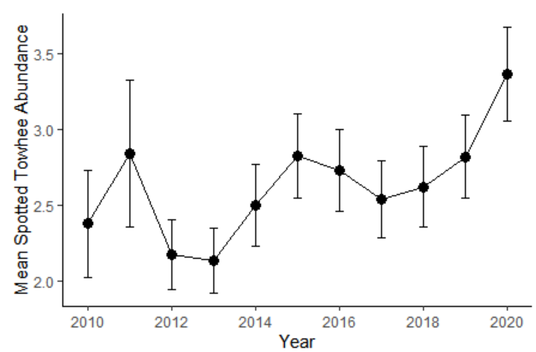
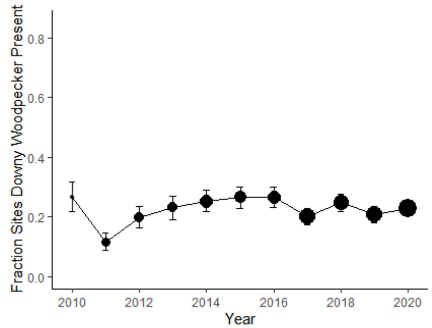
<td>
</td>
<td rowspan="2">Condition: Good
Presence/absence trend: Unchanging
Abundance trend: Improving
Confidence: High</td>
</tr>
<tr>
<td><u>Statistical Tests:</u>
No significant trend was detected for the spotted towhee.</td>
<td><u>Statistical Tests:</u>
Running a Poisson model with zero inflation (intercept and observation duration), a significant increasing trend was found (z = 2.09, df = 1, p = 0.037), with a coefficient for year of 0.020+/- 0.0095.</td>
</tr>
</table>

<table>
<tr>
<td rowspan="2">Downy wood-pecker</td>
<td>
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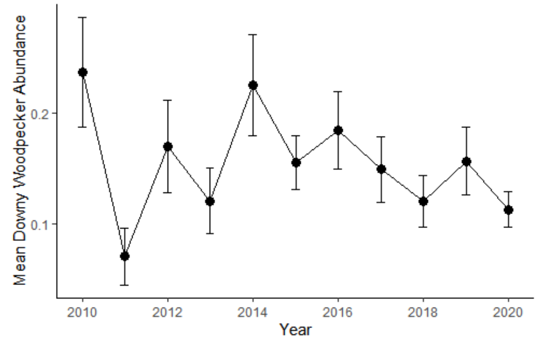
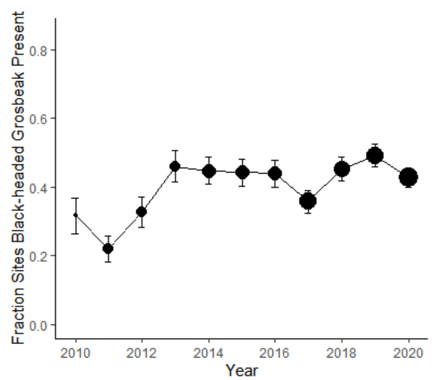
<td>
</td>
<td rowspan="2">Condition: Good
Presence/absence trend: Unchanging
Abundance trend: Unchanging
Confidence: Moderate. When abundance is plotted with the full dataset (namely, the dataset used to monitor presence/absence trends), abundance is declining.</td>
</tr>
<tr>
<td><u>Statistical Tests:</u>
No significant trend was detected for the downy woodpecker.</td>
<td><u>Statistical Tests:</u>
Running a Poisson mixed-effects model (no zero inflation), no significant trend was found.</td>
</tr>
<tr>
<td rowspan="2">Black-headed grosbeak</td>
<td>
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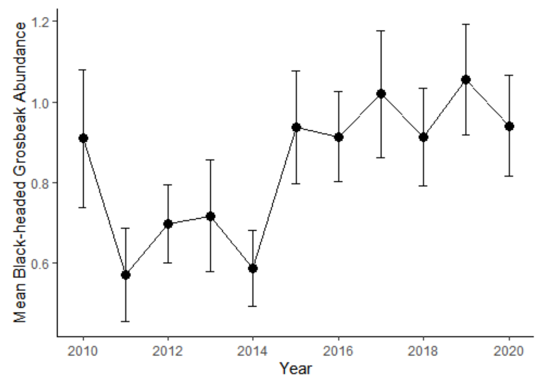
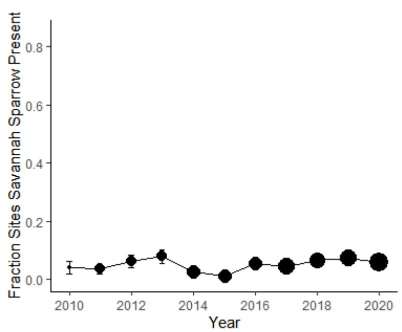
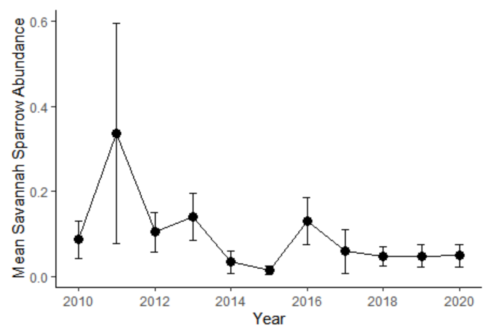
<td>
</td>
<td rowspan="2">Condition: Good
Presence/absence trend: Improving
Abundance trend: Improving
Confidence: High</td>
</tr>
<tr>
<td><u>Statistical Tests:</u>
A significant positive trend was detected for the black-headed grosbeak (z = 3.84, df = 1, p = 0.00012), with a coefficient for year of 0.066 +/- 0.017.</td>
<td><u>Statistical Tests:</u>
Running a Poisson model (with no zero inflation), a significant increasing trend was found (z = 2.96, df = 1, p = 0.0031), with a coefficient for year of 0.051+/- 0.017.</td>
</tr>
</table>

Table 6. Single species results for grassland species. Across species, the y-axis for the presence/absence figures had fixed limits (0 to 0.85) but the abundance figures had limits based on the observed abundance of the species. Significant trend coefficients are listed in bold followed by +/- and a second number; the second number is the standard error in the model coefficient. In the parenthetical for significant results are the test statistic, df = degrees of freedom, and the p-value for the test statistic. Error bars represent the standard error in presence/absence (figure on left) or abundance (figure on right).

GRASSLAND	To assess the health of grassland habitat, we analyzed trends in the savannah sparrow, grasshopper sparrow, western meadowlark, horned lark, northern harrier, loggerhead shrike, and white-tailed kite. There were enough data to analyze all of these species, although the northern harrier and loggerhead shrike results should be viewed with some caution. We had high confidence in the trend for only one species (white-tailed kite). Of the seven we analyzed, one showed evidence of increasing, two were stable, and four showed some evidence of a decline.		**Condition:** Significant Concern **Trend:** Declining **Confidence:** Low. Species had decreasing and increasing trends. We had moderate or low confidence in many individual species results. Further, observations within grasslands were undersampled compared to their fraction of the landscape.
Species	**Trend – Presence/absence with all availability data**	**Trend – Abundance data from repeat observations**	**Assessment**
Savannah sparrow			**Condition:** Caution **Presence/absence trend:** Unchanging **Abundance trend:** Declining **Confidence**: Moderate. A small fraction of the locations recorded the presence of savannah sparrows from 2015-2020; thus, the trend is based on the abundance observed at a very limited number of locations. However, the decline in abundance is robust to removing data from 2011.
	Statistical Tests: No significant trend was detected for the savannah sparrow.	Statistical Tests: Running a negative binomial model (with no zero inflation), a significant declining trend was found (z = -2.75, df = 1, p = 0.0060), with a coefficient for year of **-0.29+/- 0.11**.	

<table>
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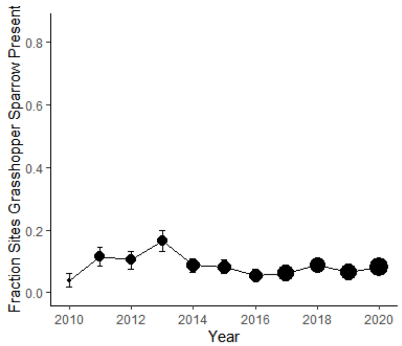
<td rowspan="2">Grasshopper sparrow</td>
<td>
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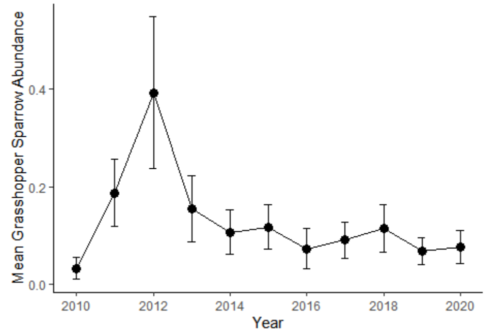
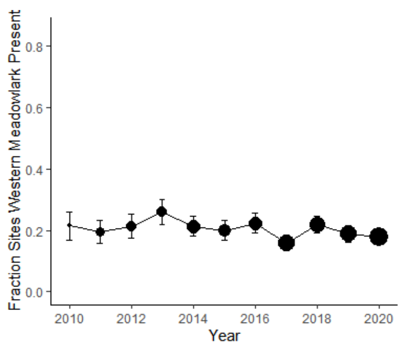
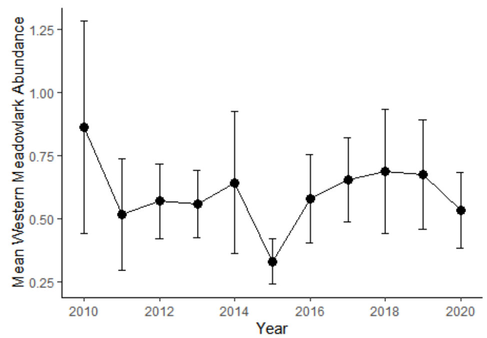
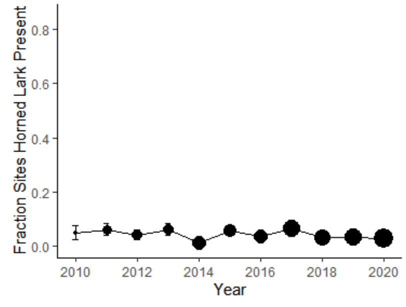
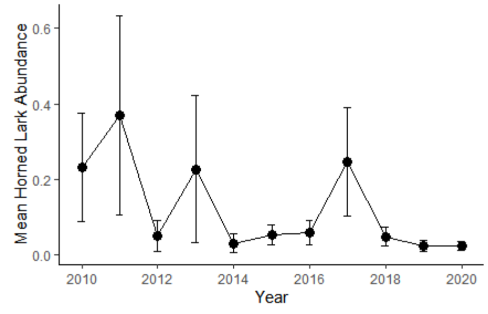
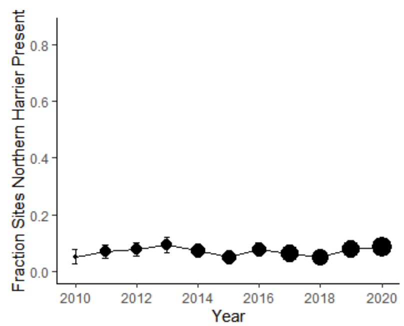
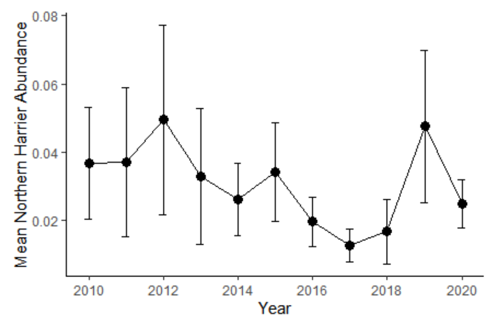
<td>
</td>
<td rowspan="2">Condition: Significant Concern
Presence/absence trend: Declining
Abundance trend: Declining
Confidence: Moderate. A small fraction of the locations recorded the presence of grasshopper sparrows. Without data from 2012, the observed decline in abundance would not be significant. There were no data within the eBird dataset to explain why 2012 had high abundance for the grasshopper sparrow.</td>
</tr>
<tr>
<td><u>Statistical Tests:</u>
A significant negative trend was detected for the grasshopper sparrow (z = -2.27, df = 1, p = 0.023), with a coefficient for year of -0.065 +/- 0.028.</td>
<td><u>Statistical Tests:</u>
Running a Poisson model (with zero inflation intercept and duration of observation), a significant declining trend was found (z = -2.30, df = 1, p = 0.021), with a coefficient for year of -0.13+/- 0.058.</td>
</tr>
<tr>
<td rowspan="2">Western meadowlark</td>
<td>
</td>
<td>
</td>
<td rowspan="2">Condition: Caution
Presence/absence trend: Declining. The year 2013 was highly influential in the full dataset.
Abundance trend: Unchanging
Confidence: Moderate. Without data from 2013, the observed decline in occupied sites would not be significant.</td>
</tr>
<tr>
<td><u>Statistical Tests:</u>
A marginally significant negative trend was detected for the western meadowlark (z = -1.92, df = 1, p = 0.055), with a coefficient for year of -0.040 +/- 0.021.</td>
<td><u>Statistical Tests:</u>
Running a negative binomial model (with no zero inflation), no significant trend was found.</td>
</tr>
</table>

Horned lark			**Condition:** Significant Concern **Presence/absence trend:** Declining **Abundance trend:** Declining **Confidence:** Moderate. A small fraction of the locations recorded the presence of horned larks (specifically, all years had <10% of observations where horned larks were present).
	Statistical Tests: A significant negative trend was detected for the horned lark (z = -2.18, df = 1, p = 0.029), with a coefficient for year of **-0.086 +/- 0.040**.	Statistical Tests: Running a negative binomial model (with no zero inflation), a significant declining trend was found (z = -2.42, df = 1, p = 0.016), with a coefficient for year of **-0.21 +/- 0.089**.	
Northern harrier			**Condition:** Good **Presence/absence trend:** Unchanging **Abundance trend:** Unchanging **Confidence:** Low. A small fraction of the locations recorded the presence of northern harriers (specifically, all years had <10% of observations where northern harriers were present).
	Statistical Tests: No significant trend was detected for the northern harrier.	Statistical Tests: Running a Poisson mixed-effects model (no zero inflation), no significant trend was found.	

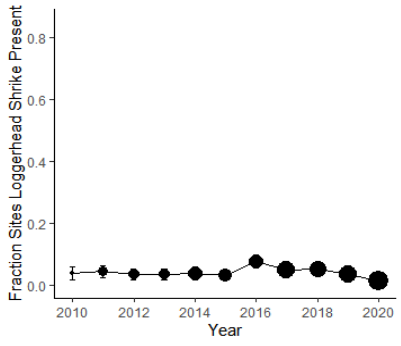
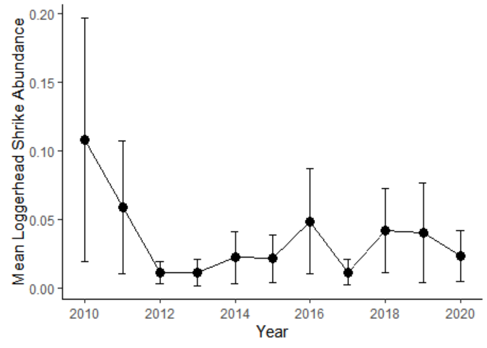
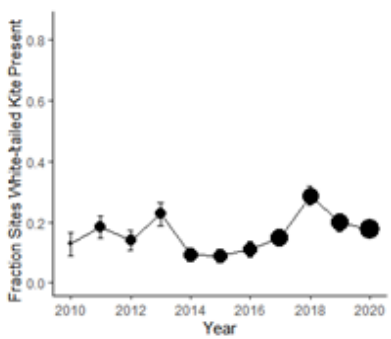
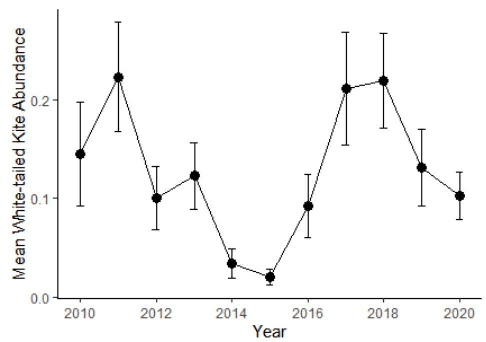
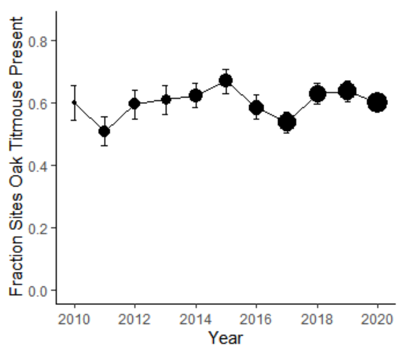
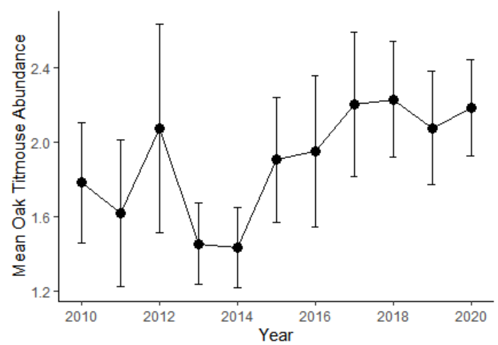
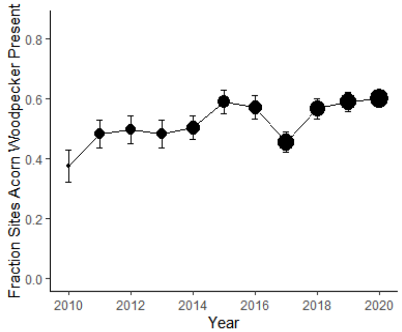
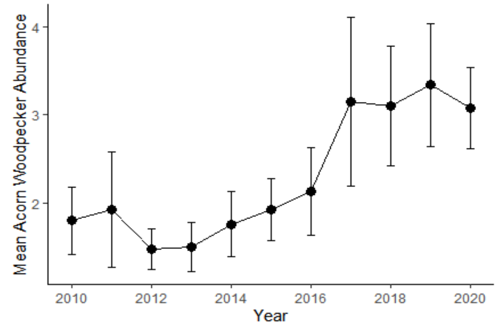
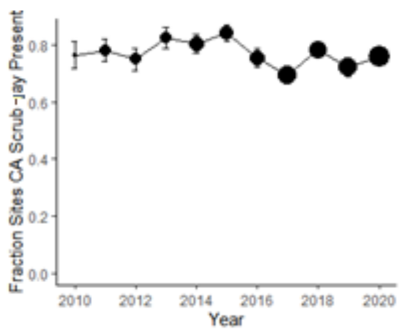
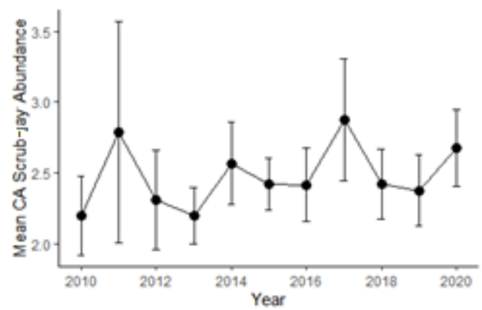
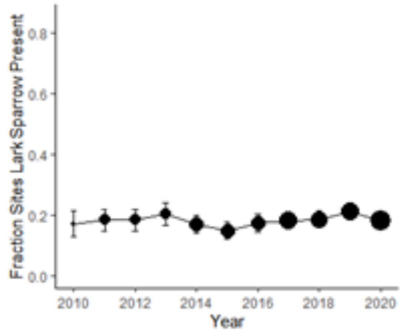
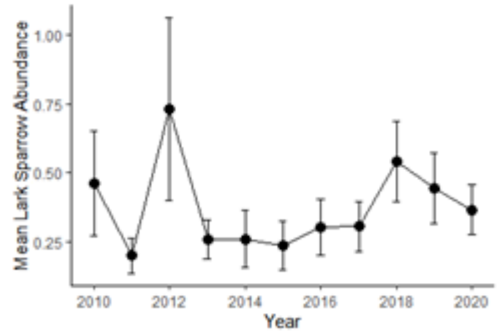
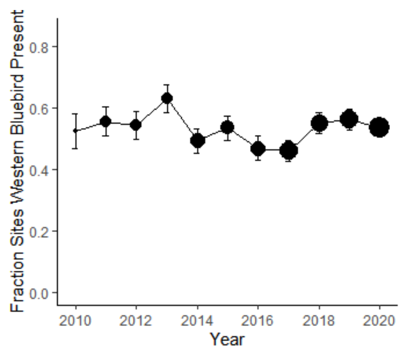
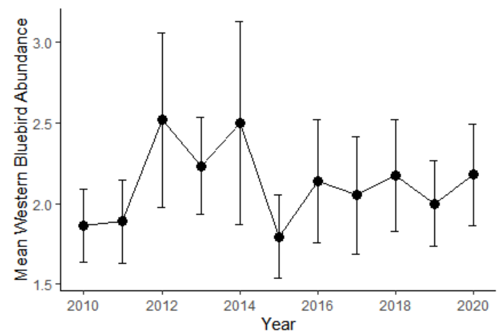
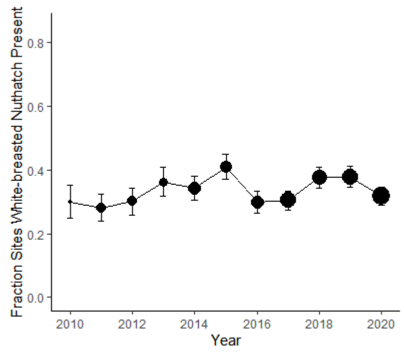
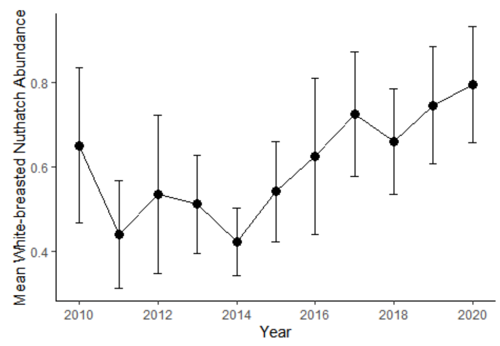
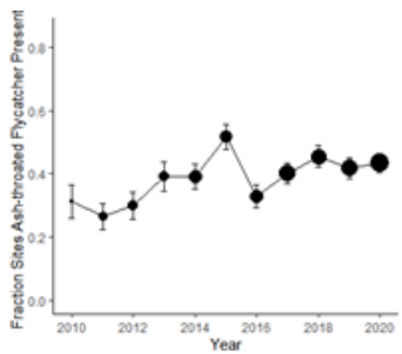
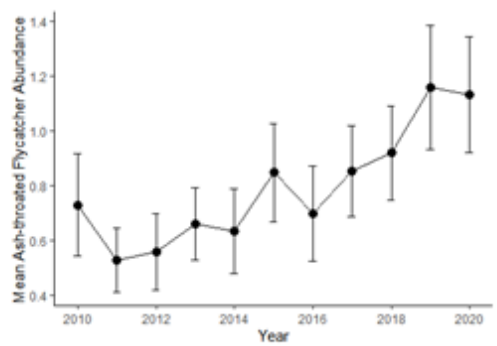
Loggerhead shrike			**Condition:** Good **Presence/absence trend:** Unchanging **Abundance trend:** Unchanging **Confidence:** Low. A very small fraction of the locations recorded the presence of loggerhead shrikes (specifically, all years had <10% of observations where loggerhead shrikes were present). The high 2010 abundance value gives the impression that the loggerhead shrike is declining, when in fact there is no significant trend. Examining the figure in detail, we see that the two highest abundance values in the first two years are largely cancelled out by the next four highest abundance values in the final five years.
	<u>Statistical Tests:</u> No significant trend was detected for the loggerhead shrike.	<u>Statistical Tests:</u> Running a Poisson mixed-effects model (no zero inflation), no significant trend was found.	
White- tailed kite			**Condition:** Good **Presence/absence trend:** Improving **Abundance trend:** Unchanging **Confidence:** High
	<u>Statistical Tests:</u> A significant positive trend was detected for the white-tailed kite (z = 2.05, df = 1, p = 0.041), with a coefficient for year of **0.046 +/- 0.022**.	<u>Statistical Tests:</u> Running a Poisson mixed-effects model (no zero inflation), no significant trend was found.	

Table 7. Single species results for oak woodland species. Across species, the y-axis for the presence/absence figures had fixed limits (0 to 0.85) but the abundance figures had limits based on the observed abundance of the species. Significant trend coefficients are listed in bold followed by +/- and a second number; the second number is the standard error in the model coefficient. In the parenthetical for significant results are the test statistic, df = degrees of freedom, and the p-value for the test statistic. Error bars represent the standard error in presence/absence (figure on left) or abundance (figure on right).

OAK WOOD-LAND	To assess the health of oak woodland habitat, we analyzed trends in the oak titmouse, acorn woodpecker, California scrub-jay, lark sparrow, western bluebird, white-breasted nuthatch, ash-throated flycatcher, Nuttall's woodpecker, and blue-gray gnatcatcher. There were enough data to analyze nine of these species with high confidence. Of the nine we analyzed, five were increasing, three were stable, and one had some evidence of a decline (California scrub-jay).		**Condition:** Caution **Trend:** Unchanging **Confidence:** High
Species	**Trend – Presence/absence with all availability data**	**Trend – Abundance data from repeat observations**	**Assessment**
Oak titmouse			**Condition:** Good **Presence/absence trend:** Unchanging **Abundance trend:** Improving **Confidence:** High
	<u>Statistical Tests:</u> No significant trend was detected for the oak titmouse.	<u>Statistical Tests:</u> Running a negative binomial model (with no zero inflation), a significant increasing trend was found (z = 3.12, df = 1, p = 0.0018), with a coefficient for year of **0.041 +/- 0.013**.	

<table>
<tr>
<td rowspan="2">Acorn wood-pecker</td>
<td>
</td>
<td>
</td>
<td rowspan="2">Condition: Good
Presence/absence trend: Improving
Abundance trend: Improving
Confidence: High</td>
</tr>
<tr>
<td><u>Statistical Tests:</u>
A significant positive trend was detected for the acorn woodpecker (z = 3.56, df = 1, p = 0.00037), with a coefficient for year of 0.061 +/- 0.017.</td>
<td><u>Statistical Tests:</u>
Running a negative binomial model (with no zero inflation), a significant increasing trend was found (z = 6.86, df = 1, $p < 10^{-5}$), with a coefficient for year of 0.092 +/- 0.013.</td>
</tr>
<tr>
<td rowspan="2">California scrub-jay</td>
<td>
</td>
<td>
</td>
<td rowspan="2">Condition: Caution
Presence/absence trend: Declining
Abundance trend: Unchanging
Confidence: High. While the mean California scrub-jay abundance is increasing through time, the trend is not significant due to the high within-year variability in abundance.</td>
</tr>
<tr>
<td><u>Statistical Tests:</u>
A significant negative trend was detected for the California scrub-jay (z = -2.40, df = 1, p = 0.017), with a coefficient for year of -0.050 +/- 0.021.</td>
<td><u>Statistical Tests:</u>
Running a negative binomial mixed-effects model (with no zero inflation), no significant trend was found.</td>
</tr>
</table>

<table>
<tr><td rowspan="2">Lark sparrow</td><td>
</td><td>
</td><td rowspan="2">Condition: Good
Presence/absence trend: Unchanging
Abundance trend: Unchanging
Confidence: High</td></tr>
<tr><td><u>Statistical Tests:</u>
No significant trend was detected for the lark sparrow.</td><td><u>Statistical Tests:</u>
Running a negative binomial mixed-effects model (with no zero inflation), no significant trend was found.</td></tr>
<tr><td rowspan="2">Western bluebird</td><td>
</td><td>
</td><td rowspan="2">Condition: Good
Presence/absence trend: Unchanging
Abundance trend: Unchanging
Confidence: High</td></tr>
<tr><td><u>Statistical Tests:</u>
No significant trend was detected for the western bluebird.</td><td><u>Statistical Tests:</u>
Running a negative binomial mixed-effects model (with no zero inflation), no significant trend was found.</td></tr>
</table>

White-breasted nuthatch			**Condition:** Good **Presence/absence trend:** Unchanging **Abundance trend:** Improving **Confidence:** High
	<u>Statistical Tests:</u> No significant trend was detected for the white-breasted nuthatch.	<u>Statistical Tests:</u> Running a Poisson model (with no zero inflation), a significant increasing trend was found (*z* = 2.31, *df* = 1, *p* = 0.021), with a coefficient for year of **0.047 +/- 0.020**.	
Ash-throated flycatcher			**Condition:** Good **Presence/absence trend:** Improving **Abundance trend:** Improving **Confidence:** High
	<u>Statistical Tests:</u> A significant positive trend was detected for the ash-throated flycatcher (*z* = 3.01, *df* = 1, *p* = 0.0026), with a coefficient for year of **0.051 +/- 0.017**.	<u>Statistical Tests:</u> Running a Poisson model (with no zero inflation), a significant increasing trend was found (*z* = 2.97, *df* = 1, *p* = 0.0030), with a coefficient for year of **0.055 +/- 0.019**.	

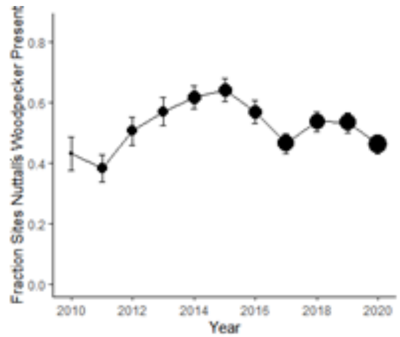
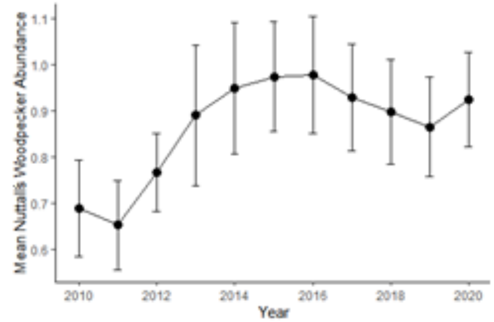
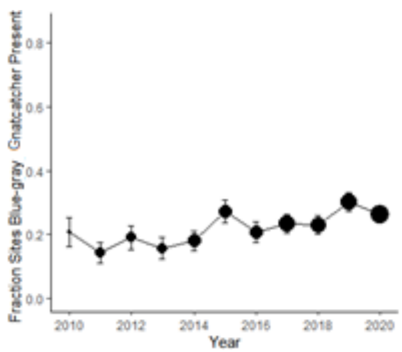
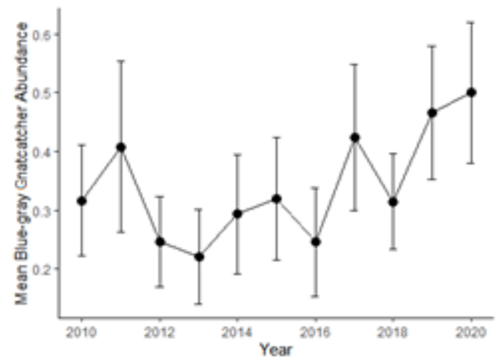
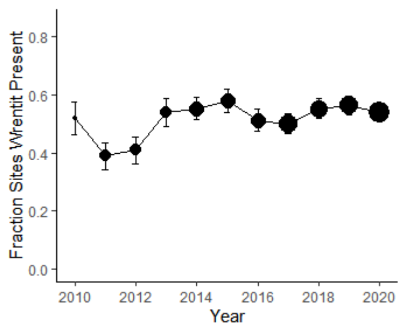
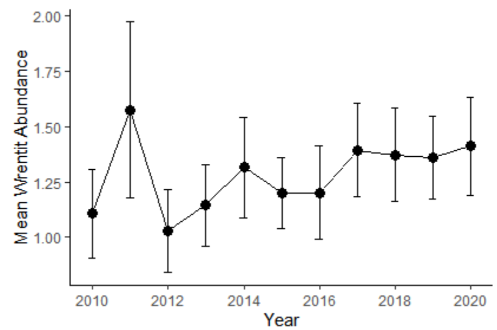
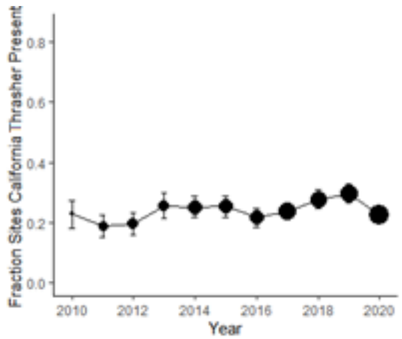
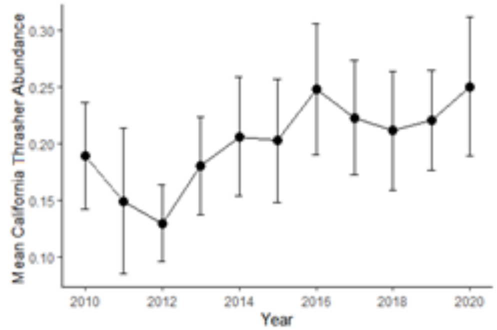
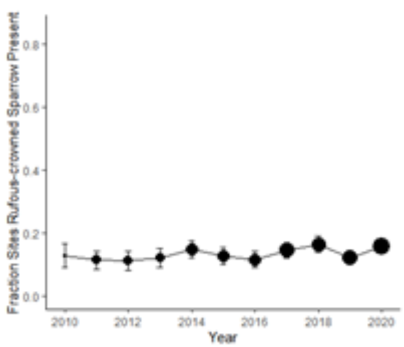
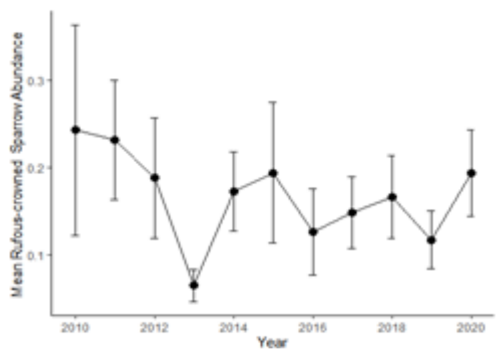
Nuttall's woodpecker			**Condition:** Good **Presence/absence trend:** Unchanging **Abundance trend:** Unchanging **Confidence:** High. While the mean Nuttall's woodpecker abundance is increasing through time, the trend is not significant due to the high within-year variability in abundance.
	<u>Statistical Tests:</u> No trend was detected for the Nuttall's woodpecker.	<u>Statistical Tests:</u> Running a Poisson model (with no zero inflation), no significant trend was found.	
Blue-gray gnatcatcher			**Condition:** Good **Presence/absence trend:** Improving **Abundance trend:** Unchanging **Confidence:** High**.** While the mean blue-gray gnatcatcher abundance is increasing through time, the trend is not significant due to the high within-year variability in abundance.
	<u>Statistical Tests:</u> A significant positive trend was detected for the blue-gray gnatcatcher (z = 2.94, df = 1, p = 0.0033), with a coefficient for year of **0.060 +/- 0.020**.	<u>Statistical Tests:</u> Running a Poisson model (with no zero inflation), no significant trend was found.	

Table 8. Single species results for shrubland/chaparral species. Across species, the y-axis for the presence/absence figures had fixed limits (0 to 0.85) but the abundance figures had limits based on the observed abundance of the species. Significant trend coefficients are listed in bold followed by +/- and a second number; the second number is the standard error in the model coefficient. In the parenthetical for significant results are the test statistic, df = degrees of freedom, and the p-value for the test statistic. Error bars represent the standard error in presence/absence (figure on left) or abundance (figure on right).

<table>
<tr><td>SHRUBLAND/ CHAPARRAL</td><td colspan="2">To assess the health of shrubland/chaparral habitat, we analyzed trends in the wrentit, California thrasher, and rufous-crowned sparrow. All three species had stable populations.</td><td>Condition: Good
Trend: Unchanging
Confidence: Moderate</td></tr>
<tr><td>Species</td><td>Trend – Presence/absence with all availability data</td><td>Trend – Abundance data from repeat observations</td><td>Assessment</td></tr>
<tr><td rowspan="2">Wrentit</td><td>
</td><td>
</td><td rowspan="2">Condition: Good
Presence/absence trend: Unchanging
Abundance trend: Unchanging
Confidence: High. Both the fraction of sites occupied by wrentits and wrentit abundance increased through time. The former had a positive trend and was almost marginally significant (z = 1.63, df = 1, p = 0.10). The latter was not significant due to the intra-annual variation in abundance.</td></tr>
<tr><td><u>Statistical Tests:</u>
No significant trend was detected for the wrentit.</td><td><u>Statistical Tests:</u>
Running a Poisson model (with no zero inflation), no significant trend was found.</td></tr>
</table>

<table>
<tr>
<td rowspan="2">California thrasher</td>
<td>
</td>
<td>
</td>
<td rowspan="2">Condition: Good
Presence/absence trend: Unchanging
Abundance trend: Unchanging, although there was a marginally significant increase in abundance.
Confidence: High. Taking a cautious approach, we define the California thrasher as “stable” because the increasing abundance trend was only marginally significant.</td>
</tr>
<tr>
<td><u>Statistical Tests:</u>
No significant trend was detected for the California thrasher.</td>
<td><u>Statistical Tests:</u>
Running a Poisson model (with no zero inflation), a marginally significant increasing trend was found (z = 1.82, df = 1, p = 0.068), with a coefficient for year of 0.072 +/- 0.040.</td>
</tr>
<tr>
<td rowspan="2">Rufous-crowned sparrow</td>
<td>
</td>
<td>
</td>
<td rowspan="2">Condition: Good
Presence/absence trend: Unchanging
Abundance trend: Unchanging
Confidence: High</td>
</tr>
<tr>
<td><u>Statistical Tests:</u>
No significant trend was detected for the rufous-crowned sparrow.</td>
<td><u>Statistical Tests:</u>
Running a Poisson model (with no zero inflation), no significant trend was found.</td>
</tr>
</table>

COMPARISON TO OTHER HIGH-PROFILE STUDY

Given recent studies suggesting the loss of three billion birds in North America since 1970 (Rosenberg et al. 2019), our analyses of recent changes in Network partner agency lands suggest that Bay Area birds are doing relatively well. Following is a brief comparison of our results to Rosenberg et al. (2019), hereafter referred to as "the Rosenberg study."

The Rosenberg study estimated both North American population size and trend since 1970. Trend data came from the North American Breeding Bird Survey (1970–2017 or 1993–2017, depending on data availability).[9] Audubon's Christmas Bird Counts and California Department of Fish and Wildlife surveys were also used. Trends were estimated based on a hierarchical Bayesian model. Thus, the single-species trends in the Rosenberg study were partially driven by vegetation or habitat type. In other words, all grassland species had trends more similar to one another than all riparian birds. This can be seen most prominently in Table 9, where grassland and shrubland species all have considerably larger population declines than oak woodland and riparian species.

Beyond differences in methods and location, the Rosenberg study and our analysis differ in spatial scale (Network partner agency lands versus North America) and time window (2010–2020 versus 1970–2017). For these reasons, we do not expect a strong match between our analysis and the Rosenberg study, but feel there is value in comparing our results to regional assessments, especially such a high-profile study.

Table 9 was calculated using species results from Supplemental Data Table S1 of the Rosenberg study. We divided the column "Loss_med" by "popest," which can be roughly translated as (Abundance Loss)/(Avg Abundance). This calculation results in some birds with declines >100%, which initially may seem problematic. However, "Avg Abundance" is not the same as initial abundance (in 1970), where initial abundance was not reported in the Supplemental Data. While not inaccurate, declines >100% (or fractional declines >1 in Table 9) reinforce the reality that because the Rosenberg study required many assumptions and approximations, results should be viewed as imprecise. This reiterates our contention that an approximate fractional decline in our indicator species across North America will likely produce different results than our eBird analysis.

Across species, the Rosenberg study reports more declining trends than our results. Additionally, there are species-specific differences between our analysis and the Rosenberg study. However, accounting for the more pessimistic trends reported in the Rosenberg study, our analyses largely agree on the relative condition of riparian, grassland, and oak woodland birds. Specifically, our results

[9] For Network partner agency lands, there is a single breeding-bird survey (for Moraga).

agree on 5/9 riparian species, 4/7 grassland species, 7/9 oak woodland species, and on none of the shrubland species. We have high confidence in our trends for the 2/4, 1/3, 2/2, and 3/3 species that disagree for riparian, grassland, oak woodland, and shrubland species, respectively. The biggest differences are in the combined results of shrubland habitat, where we disagreed across all species and we had high confidence in all of our trends. Our analysis shows that the three shrubland species—wrentit, California thrasher, and rufous-crowned sparrow—are doing well, whereas the Rosenberg study shows moderate (wrentit and rufous-crowned sparrow) and large (California thrasher) declines. As previously mentioned, habitat type influences the species results in the Rosenberg study. The Rosenberg study designates wrentit, California thrasher, and rufous-crowned sparrow breeding habitat as "Aridlands," where, in their study, the majority of species in this group are increasing. Therefore, according to the Rosenberg study, the wrentit, California thrasher, and rufous-crowned sparrow are doing poorly within a group that is otherwise doing moderately well.

Table 9. Comparisons of our results to Rosenberg et al. (2019). Colors in the column "Rosenberg Fraction Pop Change" represent population change, with declines in shades of red and orange and increases in shades of green. We calculated this column by dividing the column "Loss_med" by the column "popest" in Rosenberg et al. 2019's Supplemental Data Table S1. The column "eBird analysis" summarizes the trends from Tables 5–8. In this column, the text is red if we report an increase or stable population when Rosenberg et al. 2019 reports a fractional decline greater than 0.1. The column "Confidence" summarizes our assignment of confidence from Tables 5–8. In this column, the text is red if the same row in the eBird analysis is red and we report high confidence.

Habitat	Species	Rosenberg Fraction Pop Change	eBird Analysis	Confidence
Riparian	Wilson's warbler	-1.00	Improving	High
Riparian	Belted kingfisher	-0.84	Unchanging	Low
Riparian	Tree swallow	-0.69	Improving	High
Riparian	Song sparrow	-0.44	Some evidence of decline	Moderate
Riparian	Yellow warbler	-0.33	Unchanging	Low
Riparian	Spotted towhee	-0.08	Improving	High
Riparian	Downy woodpecker	0.02	Unchanging	Moderate
Riparian	Black-headed grosbeak	0.23	Improving	High
Riparian	Warbling vireo	0.36	Improving	High

Habitat	Species	Rosenberg Fraction Pop Change	eBird Analysis	Confidence
Grassland	Loggerhead shrike	-2.24	Unchanging	Low
Grassland	Grasshopper sparrow	-2.09	Declining	Moderate
Grassland	Horned lark	-1.81	Declining	Moderate
Grassland	Savannah sparrow	-0.83	Some evidence of decline	Moderate
Grassland	White-tailed kite	-0.77	Improving	High
Grassland	Western meadowlark	-0.68	Some evidence of decline	Moderate
Grassland	Northern harrier	-0.42	Unchanging	Low
Oak Woodland	Oak titmouse	-0.82	Improving	High
Oak Woodland	Lark sparrow	-0.41	Unchanging	High
Oak Woodland	California scrub-jay	-0.10	Some evidence of decline	High
Oak Woodland	Blue-gray gnatcatcher	0.14	Improving	High
Oak Woodland	Acorn woodpecker	0.21	Improving	High
Oak Woodland	Western bluebird	0.33	Unchanging	High
Oak Woodland	Ash-throated flycatcher	0.38	Improving	High
Oak Woodland	Nuttall's woodpecker	0.41	Unchanging	High
Oak Woodland	White-breasted nuthatch	0.65	Improving	High
Shrubland	California thrasher	-0.80	Improving	High
Shrubland	Rufous-crowned sparrow	-0.37	Unchanging	High
Shrubland	Wrentit	-0.35	Unchanging	High

CODE USED IN ANALYSES

To allow Network partner agencies to repeat these analyses in later years, we provide annotated code and three scripts, all of which can be found in a Github repository (https://github.com/erinconlisk/EBSNEcoHealth). The three scripts are described below.

Ideally, anyone using the code would be familiar with R. However, for individuals familiar with coding in other languages, R is easy to pick up (numerous online tutorials are available). Important for initial deciphering of the code, any text in green following a hash (#) is not "active" and will not be executed. Text starting with # is used to explain what happens in the proceeding few lines. We have also placed a # in front of code that you may want to use sparingly; to activate it, remove the #.

1) eBird_allspp_text_to_shapefile.R

This code takes an eBird text file (an excerpt of the full eBird data) and creates GIS shapefiles for observations that lie within Network partner agency boundaries for a specific species in a specific year. In the resulting shapefiles, repeat locations (i.e., with the same location ID) on a given day are removed, but multiple observations within a 100 m- or 200 m-grid cell have not been averaged, nor have the grid cells been averaged over the breeding season.

The folder created for the files is made in this script and named as a four-letter code derived from the first two letters of the genus combined with the first two letters of the species. For example, the rufous-crowned sparrow's scientific name is *Aimophila ruficeps*; thus, the folder has the label "Airu" followed by "_eBird_data_by_yr." Inside the folder are files for each year, labeled with the same four-letter code, followed by the year.

Before beginning the script, do the following:

- Download other eBird data by registering, signing in, and requesting access. The process starts here: https://ebird.org/data/download
    a. We downloaded data for California from January 2010 to December 2020. The resulting file is titled: "ebd_US-CA_201001_202012_relJan-2021.txt." The title of this file reflects its contents; "ebd_US-" means eBird USA, followed by "CA" (the state), and dates (201001 [January 2010] and 202012 [December 2020]).
    b. This excerpt of eBird data is very large and takes a long time to load. To be able to continue loading eBird data directly, request a manageable excerpt of data. Trying to upload the whole eBird data is not possible in R without using the eBird package "auk." (We found this package to be difficult to use and so did the data processing ourselves.)

       Note that in the script there is a command—save.image(paste(ebirdpath, "eBird_loaded.RData", sep="")), which saves the text file as an R project after some initial processing has been completed. This is advised.

Then load the data with the command: load(paste(ebirdpath, "eBird_loaded.RData", sep="")) with "ebirdpath" being the directory to which you want to save the file (e.g., "C:/").

c. Finally, here is a link to the eBird data used in this assessment. The file is too large to upload to the repository or share by email: https://drive.google.com/file/d/1PmMkw1Zp8W1o3nbPyLDjbljquQOrkIIZ/view?usp=sharing

- To find Network partner agency boundaries: "AgencyBoundary_dissolve_rprj"
- To choose the species, see the list of scientific names in the script, starting around line 150.
- For packages listed at the top (with elements) "library(PACKAGE NAME)." To install packages, use the command: install.packages("PACKAGE NAME").

2) eBird_allspp_abundance_rasters.R

This code downloads all eBird relative-abundance rasters within Network partner agency lands for each week for a specific species and averages them across the breeding season. Relative-abundance rasters were created by Cornell to use all of the North American eBird data to model locations where abundances are expected to be highest or lowest for each week across the year (they do not include trends across years).

For the purposes of analyzing eco-health trends on Network partner agency lands, these rasters are not necessary. Instead, these rasters were used as background checks for biases in eBird data relative to Network partner agency lands. For example, observations made in 2010 could theoretically occur only in locations where Cornell predicted the highest relative abundance, whereas observations made in 2020 could occur only in locations with the lowest relative abundance. If this were the case, then the 2010 data would be occurring in locations with high habitat suitability, whereas the 2020 data would be in locations with low habitat suitability. This would introduce significant bias.

Unfortunately, eBird relative abundance rasters were not sufficiently resolved to expose biases. While we saw little bias in the eBird relative-abundance values across locations and years, we did see bias when we looked at the land-cover types underlying eBird observations. Because the land-cover background check exposed more bias, we focused on land cover as the primary means to mitigate biased sampling in Network partner agency data.

Before beginning the script, you will need ArcGIS to properly process the relative-abundance rasters created in this script. See line ~275 for a description of the tasks requiring ArcGIS. We also provide the beginning of R code to do the same work, but this code has not been vetted.

- To choose the species: See the list of scientific names in the script, starting around line 110.

- To install the packages listed at the top with elements “library(PACKAGE NAME)”: Use the command: install.packages("PACKAGE NAME"). These packages should be the same packages as were needed for eBird_allspp_text_to_shapefile.R.

3) eBird_allspp_grid_analyze_and_figures.R

This code takes the output of "eBird_text_to_shapefile_allapp.R" and averages the observations within a grid cell on a specific day. The resulting daily grids are then are averaged across the breeding season. The result is one grid per year of average counts (across grid cells and across days), which is used in trend analyses. As previously described, two analyses are performed on (a) presence/absence data across all eBird observations, and (b) abundance within locations with repeat observations.

Before beginning the script, you will need the file “focal_buffer_dissolve” to create boundaries for point-density calculations. The script runs without this file, but without the figure, you will see error messages for the calculations of point density.

You will also need to:

- Set the variable ‘ArcGIS’ in the script to either 0 or 1, depending on whether you have calculated, resampled, and reprojected the eBird relative abundance files (these rasters are created with the script “eBird_allspp_abundance_rasters.R”).
- Acquire the file “focal_rast” OR “foc_rast200m.”
    a. The former is for species with max territory size less than 4 ha (which uses a grid cell resolution of 100 m), and
    b. the latter is for species with max territory size greater than 4 ha (which uses a grid cell resolution of 200 m).
- Choose the species. See the list of scientific names in the script, starting around line 120.
- Install the packages listed at the top with elements “library(PACKAGE NAME).” To install packages, use the command: install.packages("PACKAGE NAME"). These packages should be the same packages as were needed for “eBird_allspp_text_to_shapefile.R.”

LITERATURE

Bay Area Open Space Council. (2019). *The conservation lands network 2.0 report*: *Coarse filter vegetation (*CLN 2.0). [Dataset]. Accessed July 2021. https://www.bayarealands.org/maps-data/

Fink, D., Auer, T., Johnston, A., Ruiz-Gutierrez, V., Hochachka, W., and Kelling, S. (2019). Modeling avian full annual cycle distribution and population trends with citizen science data. *Ecological Applications*, *30*(3), e02056. https://doi.org/10.1002/eap.2056

Johnston, A., Hochachka, W. M., Strimas-Mackey, M. E., Gutierrez, V. R., Robinson, O. J., Miller, E. T., Auer, T., Kelling, S. T., and Fink, D. (2021). Analytical guidelines to increase the value of community science data: An example using eBird data to estimate species distributions. *Diversity and Distributions*, *27*(7), 1265–1277.

Rosenberg, K. V., Dokter, A. M., Blancher, P. J., Sauer, J. R., Smith, A. C., Smith, P. A., … Marra, P. P. (2019). Decline of the North American avifauna. *Science*, *366*(6461), 120–124. 10.1126/science.aaw1313

Shuford, W. D., and Gardali, T. (Eds.). (2008). *California bird species of special concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California.* (Studies of Western Birds No. 1). Western Field Ornithologists and California Department of Fish and Game.

U.S. Fish and Wildlife Service. (2021). *Birds of conservation concern*. U.S. Department of the Interior. https://www.fws.gov/migratorybirds/pdf/management/birds-of-conservation-concern-2021.pdf

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APPENDIX G. DATA ASSEMBLY FOR MAMMAL INDICATORS *INTERNAL RECORDS*

NatureCheck Ecological Health Assessment

East Bay Stewardship Network

November 20, 2021

By

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Wildlife Ecology & Consulting

List of Tables

Supplemental Tables

List of Figures

Introduction

The Ecological Health Assessment (EHA) for the East Bay Stewardship Network identified an Area of Focus with three subregions (Fig. 1). As part of the Ecological Health Assessment for the East Bay Stewardship Network, Mammal Indicator worksheets included basic information on range and occurrences within the Area of Focus. This effort included querying public databases [Arctos (museum records), California Natural Diversity Database (CNDDB), Global Biodiversity Information Facility (GBIF) among others). Recommendations resulting from the expert workshop for the Ecological Health Assessment (January 2020) included updating the Ecological Health Assessment Mammal Indicator Worksheets with records data internal to the East Bay Stewardship Network (not publicly available). The Stewardship Network potentially has records for some or all the mammal indicator species; these data or records may have been collected for a variety of reasons (for example, can be ancillary to permitted requirements). This report includes methods and results from aggregating internal records including identified sources and studies, the type of data available, on-going studies that could provide data in the future, and results from aggregating available records. This report includes obtained records for bobcat (*Lynx rufus*), coyote (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), American badger (*Taxidea taxus*), ringtail (*Bassariscus astutus*), spotted skunk (*Spilogale gracilis*), least-tailed weasel (*Mustela frenata*), puma (*Puma concolor*), woodrat (*Neotoma fuscipes*), and California ground squirrel (*Otospermophilus beecheyi*).

The first part of this task was to identify potential sources of records data from each Network Partner. Camera trapping studies (those with metadata) were of particular interest as they are common monitoring tool for mammals and provide date, location, and verifiable records. Other databases that may contain records with data and location with observer. Acoustic bat monitors and other bat survey techniques can provide bat records.

After identifying camera trap studies and sources of records data useful for the mammal indicators within the Stewardship Network, the next task was to obtain the records data and the associated metadata. Records and metadata for sensors (location, type, dates active in the field, for example) were assembled resulting in two main databases: 1) metadata for sensors (location, when operational in field, settings, type of sensor) and study details (target species, duration), and 2) records (species, date, time, location, or sensor identification). As part of this effort, camera data (images) were collected (both processed and unprocessed as able) and the integrity of the metadata was assessed for future inventory. Not all camera and bat data had been processed for use in this analysis (May 2021) but the records data that were available were aggregated and findings from this effort are presented here. Sensor locations (cameras and acoustic monitor locations) for past and current studies were assembled and plotted (see Fig. 2) and are discussed in this report.

We have also collected the unprocessed data as able and are in the planning process for identifying these images. The Stewardship Network hopes to upload images into Wildlife Insights (www.wildlifeinsights.org), a cloud-based camera trap software, which can be used to identify, organize, and analyze camera images in a central database. These data will supplement the EHA efforts by augmenting baseline information that we are presenting here as these data become available. Additionally, a number of ongoing monitoring projects are underway (see Fig. 2 for location of active cameras) and they are described in this report.

Methods

Data aggregation

As recommended from the EHA expert workshop and described in the Introduction, existing data from the Network Partners were aggregated to augment the publicly available data that were used for the preparation of the Indicator Mammal Worksheets. Several sources of mammal data (records) internal to the Stewardship Network were identified including the EBMUD mammal database, acoustic bat surveys and camera trapping projects that were completed or on-going at the time of the data assembly. Image data from the camera studies fell into three categories: 1) images were catalogued and available for use (“available records”), 2) images were stored but had not been reviewed and 3) cameras were collecting images but data had not been recovered from the field. Attempts were made to compile metadata for these camera studies that included date range (when project started and finished or if it was ongoing), deployment (effort or trapnights), location, sensor type (make, model), settings (images per event, for example), target species (wildlife species recorded) and reported (species per image, record for first detection per species or only recording target species, for example); some of these details are included in a data summary table (Table 1; see Supplemental Table x: TBD).

Metadata for other sensors on the landscape included bat acoustic monitors; these efforts were concurrent with the EHA chapter preparation and mapping areas that had been or were currently being monitored (Fig. 2). Additional sensors on the landscape included audiomoths (not included in this analysis). This effort records audio files from bird, biodiversity sound metrics and some mammals such as coyote and ground squirrels; we expect these data to be used in the future assessments of the mammal indicator species on presence and prevalence.

Sensor data (active and inactive) were organized to show coverage of Stewardship lands and to indicate which sensors provided data for this effort. Active sensors indicated sensors that were active at the time of this study (2021) and "inactive" indicated sensors that were no longer on the landscape (representing location of sensors from past studies). Records were aggregated to compile species detection totals by park, subregion and by year. These findings were also used to build detection and non-detection tables by monitored park and subregion, which served as a basis for a metric for many of the indicator species. Additionally, the sensor locations provided insight into what portion of the Stewardship lands have been or currently being monitored for mammals.

Results

Summary of Studies

Ten camera studies on Stewardship Lands were identified as potentially able to provide information for this study; these efforts included 290 camera locations across the three subregions (71 in the East Bay Hills, 75 in Mount Diablo, and 144 in Mount Hamilton; Table 1 and Fig. 2). Metadata were used to plot locations and included in this figure is the status of sensors (active and inactive) and if records were used in analysis (Fig. 2). Camera studies encompassed one or more parks in one or more subregions (see Supplemental Table: TBD). We compiled all mammal species records we received (Table 2a and 2b).

Of these (see Table 1 for summary efforts), six of the ten studies provided records (see "records analysis" column in Table 1) as well as an EBMUD mammal database (observations from staff) for this analysis; 48 cameras in the East Bay Hills (2016 - 2020), 31 in Mount Diablo (2017 - 2020), and 54 in Mount Hamilton [2012 - 2020); see Table 1]. We used records available from these studies for this analysis, however, the lack of critical metadata such as effort (number of operational trapnights) precluded determining detection rates (detections per unit effort). For this analysis, we reported indicator mammal detections for each park or land unit in each subregion, we compiled detections and non-detections per park (or land unit) for those parks with sensors or for EBMUD lands (mammal database; Table 3) and total detections annually (Table 4a-f).

Bat detections were recorded in the EBMUD mammal database, but bats were not reported (and are rarely recorded) from the camera studies records. Bat records internal to the Stewardship Network were compiled from ad hoc bat surveys and additional efforts such as roost exit data were compiled and included in the for the EHA Bat Indicator Chapter but not here in this report. Some of the acoustic bat monitors are shown on the sensor figure (Fig. 2).

Records

EBMUD provided a records database of notable mammal sightings (records with date, time, and location) ranging from 1869 (one record) to 2020 (845 records in total). We included because the location and date for indicator species were available (for example, a ringtail record and the puma records) for a large portion of the lands in the East Bay Hills subregion. Additionally, EBMUD had unprocessed image data from 6 cameras "EBMUD Ad Hoc." Records were not available for inclusion in this data aggregation; however, sensors were included in sensor figure and image data were obtained to be processed in the future.

The EBRPD Carnivore Study (Tilden-Sibley Fuel) in the East Bay Hills conducted from 2016 to 2020 with 48 unique camera locations provided 26,902 records of which a subset included indicator species. This study focused on deer and mesocarnivores; species such as woodrat and ground squirrel were not recorded. Deployment dates (start date and end date for each camera) were not available; effort was not assessed. Additionally, the number and location of cameras that were up and functioning in any given year were not available.

The EBRPD Carnivore Study (Sunol-Ohlone) in the Mount Hamilton subregion was conducted from 2012 to 2020 and records from 9 unique camera locations from 2012 to 2018 were available for this analysis; deployment dates were not available, so effort was not assessed. Target species included carnivores and small mammals such as the woodrat. The number and location of cameras operational in any given year were not available.

The EBRPD Carnivore Study (Eastern Contra Costa County; "ECCC") in Mount Diablo subregion spanned 2019 to 2020 with 5,283 records from 10 camera locations; trapnights (effort) were available (from Clayton Ranch, 2,121 records from 1036 trapnights; from Morgan Territory, 2,825 records from 2,276 trapnights; and from Round Valley, 336 records from 285 trapnights). This study focused on carnivores, so woodrat and ground squirrel were not reported (Bobzien and Douglas 2020).

The Large Mammal Occupancy Study at the Carnegie SVRA in Mount Hamilton subregion provided records from 2017 to 2020 from 27 camera locations; records included carnivores and ground squirrels. Effort for each camera was not available (effort or trapnights).

Seven Habitat Management Units ("HMUs") were monitored as part of mitigation for the San Joaquin kit fox for the Contra Costa Water District Los Vaqueros Reservoir Expansion Project; five HMUs with 15 cameras were located in the Mount Diablo subregion and two HMUs with 18 cameras in the Mount Hamilton subregion (Fig. 2). The HMUs ranged in size from 80 ac (Los Vaqueros HMU) to 3,021 ac (Corrale Hollow HMU). Target species included carnivores; some other species were also recorded.

Only 1 record of target species was recorded for each month of operation and effort (functional trapnights) was not reported.

Ten cameras were deployed by Felidae (www.felidaefund.org) in Mount Diablo State Parks in 2020 and records from 6 of these cameras were available and used in this analysis. Effort was reported and the cameras are still deployed. Carnivores were the target species, but other species were recorded.

Current camera trapping studies, as well as unprocessed data from earlier studies, will provide additional records data covering lands and longer time series (see Fig. 2 for active cameras). Active studies include on-going camera studies at CSVRA, San Joaquin kit fox mitigation HMUs, Felidae cameras at Mount Diablo State Park, and new studies including Post-Fire Monitoring study (40 cameras set up in November 2020 in burned and unburned parks including Round Valley, Morgan Territory and CCWD Los Vaqueros Watershed) and an EBRPD Panthera study with 91 cameras in the Mount Hamilton subregion and 18 cameras in the East Bay Hills set up in 2020 and early 2021. Unprocessed images from earlier studies included EBMUD Ad Hoc cameras (6), EBRPD Carnivore Research (Sunol-Ohlone; 2018_2020), CCWD Kit Fox Monitoring prior to and after 2017, and CSVRA camera records (State Parks) from 2014_2016 could provide additional information (Table 1).

Total yearly detections for each park and subregion were tallied for each indicator species (bobcat, coyote, gray fox, badger, puma, ground squirrel, and woodrat; see Tables 2a, 2b, 3a - e). Camera number (effort; Table 1) varied per site per year, trapnights were unknown and image data was processed differently as mentioned, tallied totals reflect reported total detections (Table 2a and 2b).

Mesocarnivores

Bobcat, coyotes, and gray fox, and were detected in each subregion but not in all parks and not in some years (Table 3 and 4a-c). Bobcat were recorded in all parks with sensors in each subregion (3,756 records). Coyote were detected in all but the San Pablo Reservoir (EBMUD, records; 15,061 records). Gray fox were detected in all but EBMUD Lafayette Reservoir in the East Bay Hills (2,260 records), in three of the nine monitored parks in Mount Diablo (101 records), and 3 of 5 parks for Mount Hamilton subregion (1,932 records; Table 2a).

The common mesocarnivores (bobcat, coyote, and gray fox) detections (1s) and non-detections (0s) by year and by site were compiled for parks for which records were available (EBMUD lands and identified camera projects; see Table 3) and used to indicate presence in a park/unit (Figs. 3, 4, and 5). Monitored parks and land units include those parks that had records for this analysis. Bobcat were detected in all 18 monitored park or land unit (100%) in each subregion for the Area of Focus. Coyotes were detected in 17 of the 18 monitored Parks (94%); 9 units in Mount Diablo, 4 units in Mount Hamilton, and 4 of 5 units in East Bay Hills (80%; Fig. 4 and Table 3). Gray fox were detected in 9 of 18 park or land units (50%), 4 of 5 in East Bay Hills (80%), 3 of 9 in Mount Diablo (33%), and 2 of 4 in Mount Hamilton (50%; Fig. 5 and Table 3).

Badger were detected in each subregion and in 8 of 18 (44%) monitored parks and land units with EBMUD records; badger were detected in 1 of 5 parks/land units in East Bay Hills (4 observations from the EBMUD property), 4 of 9 parks in the Mount Diablo subregion (20 records), and 2 of 4 parks in the Mount Hamilton subregion (3 records). Mount Diablo and Mount Hamilton subregions park units are large, open and provide highly suitable habitat for the badger; they would be expected to occur there. Four of 5 CCWD HMUs (2017_2020) in the Mount Diablo subregion and both CCWD HMUs in Mount Hamilton (2017_2020) detected badger. Detections were low for all monitored parks; however, for each park where they were detected, they were detected in 2020 (Table 4). The baseline indicates that badger were present in each subregion but no evidence that they are widespread in any of them; also, badger were not detected in monitored parks where they would be expected to occur.

The Network Partner records included a ringtail from 1997 (N37.929797, -122.236644; northeast of San Pablo Reservoir, EBMUD) and a long-tailed weasel from 2018 (N37.7530, -122.070568 southeast of San Leandro Reservoir, EBMUD) from the East Bay Hills subregion. No spotted skunk were included in the aggregated records from the Area of Focus. No ringtail and long-tailed weasel were recorded from the Mount Diablo and Mount Hamilton subregions.

Other non-Network Partner records from the *Vasco Amphibian Undercrossing Pilot Study* (2019) included long-tailed weasel and spotted skunk detections in the Mount Diablo subregion (Jan 2017 – May 2018); ten instances of spotted skunks and two instances of long-tailed weasels were recorded in culverts under Vasco Road. These culverts are located between EBRPD Vasco Caves and Byron Vernal Pools. According to the CNDDB prior to 2016, badger were detected in each subregion. After 2016, only one occurrence was recorded from the Mount Hamilton subregion (but not on Network Stewardship lands; CNDDB also sometimes lags in data input).

Puma

Puma were detected in East Bay Hills (101 records, 48 cameras set for varying periods of time from between 2016 to 2020 and EBMUD mammal database; Table 2a and Fig. 7), and Mount Hamilton (650 records from 3 of the 5 monitored parks). Effort included 54 cameras for varying periods of time from 2012 to 2020 for this subregion. No puma detections were recorded in the Mount Diablo subregion. Effort from this subregion included 31 cameras set in 9 parks for varying periods of time from 2017 to 2020. Puma were detected in 8 of the 18 monitored parks in the East Bay Hills and Mount Hamilton subregion and none in the Mount Diablo subregion (Tables 2a and 3).

Ground Squirrel

Camera trapping records of ground squirrel were aggregated by park and subregion. The Network Partner records data included detections in 1 of 5 parks in the East Bay Hills (4 records), 4 of 9 parks in the Mount Diablo subregion (102 records), and 3 of 5 parks in the Mount Hamilton subregion (134 records; Table 2a and Table 3). Network records data were limited in that the camera studies did not reliably report ground squirrel detections.

Other sources of information were used for the California ground squirrel indicator species metrics. The Stewardship Network partners were queried about recent knowledge or records of ground squirrel presence in the land units or parks in the Area of Focus. As part of a California ground squirrel study on EBRPD lands (Townsend and Lenihan 2021) conducted in late spring 2021, EBRPD parks were visited to document presence of ground squirrels. From the INat query, research grade and select user observations resulted in 1,430 observations out of the 1,466 from INat California ground squirrel query (August 4, 2021). Of these, 203 observations were from 2004 to 2016 and 1,227 observations were from 2017 to 2021. This effort is not included in this Data Assembly Report.

Woodrat

Woodrats were reported from the East Bay Hills (88 records were recorded from EBMUD Property, Lafayette Reservoir and San Pablo Reservoir) and from Ohlone Wilderness (61 records) in the Mount Hamilton subregion (Table 2b). Woodrats were detected in 3 of 5 (60%) monitored parks or land units with records in the East Bay Hills subregion (Table 2). Woodrats were detected in the EBMUD lands but there were no camera records from Sibley Volcanic or Tilden likely due to not recording this species. Woodrats were detected in Ohlone Wilderness in Mount Hamilton subregion and not detected (recorded) from monitored parks from Mount Diablo subregion (Table 2). Camera records from monitored parks were compiled although some of the monitored sites lacked suitable habitat.

Records for this species were sparse. Processing existing camera trap data in its entirety may provide additional information on the presence within the Area of Focus.

Bats

The EBMUD mammal database had records for bats; these are not presented here. Other sources from partners included survey results from EBRPD and monitoring at the CSVRA. These records were important for documenting species richness for the Areas of Focus and individual parks (Metric 1). Two additional datasets of EBRPD bat surveys (2004 to 2015 and 2017 to 2020), both acoustic and emergent. Bat houses, roosts and survey locations were compiled and mapped. Data for the suite of bat species is included in the Bat Indicator Chapter from the EHA Report (2022).

Summary

Total yearly detections for each park and subregion were tallied for each indicator species (bobcat, coyote, gray fox, badger, puma, ground squirrel, and woodrat; see Tables 2a, 2b, 3a - e). Camera number (effort; Table 1) varied per site per year, trapnights were unknown and image data was processed differently as mentioned, tallied totals reflect reported total detections (Table 2a and 2b) but were not used in determining abundance or change over time. The detection and non-detection results for the monitored park/land unit level were used for Ecological Health Assessment metrics. Total detections without reported effort are not particularly useful to assess abundance or change over time (provided in this report) but records from monitored areas do provide detection and non-detection data (see Indicator Mammal Chapters from the EHA). Some of the indicator species such as the woodrat and ground squirrel were not reliably included in processed image data (a non-target); in other words, woodrat and ground squirrel may have been detected by the cameras but not recorded (however, whether or not and when these species were included was not always clear from the studies objectives). Therefore, a note of caution that this analysis included aggregating available records but reporting from these studies was not standardized.

However, with improvements in consistency in metadata reporting, detection rates and, in some cases like the post-fire monitoring and Panthera study, occupancy estimation can be used to compare sites and trends in abundance for future analyses. Rare species also may be detected. Prior to this effort, it was unknown what data was available and what proportion of the Stewardship Lands had been monitored. The detection and non-detection metric for mesocarnivores, puma, ground squirrel and woodrat were vetted as a metric to assess conditions during the expert workshop as an appropriate approach (January 2020).

Current camera trapping studies, as well as unprocessed data from earlier studies, will provide additional records data covering lands and longer time series (see Fig. 2 for active cameras) for future analysis – the results from these findings can be used to update the baseline condition assessments and provide additional findings to assess trends (are conditions improving or declining, for example). Active studies include on-going camera studies at CSVRA, San Joaquin kit fox mitigation HMUs, Felidae cameras at Mount Diablo State Park, and new studies including Post-Fire Monitoring study (40 cameras set up in November 2020 in burned and unburned parks including Round Valley, Morgan Territory and CCWD Los Vaqueros Watershed) and an EBRPD Panthera study with 91 cameras in the Mount Hamilton subregion and 18 cameras in the East Bay Hills set up in 2020 and early 2021. Unprocessed images from earlier studies included EBMUD Ad Hoc cameras (6), EBRPD Carnivore Research (Sunol-Ohlone; 2018_2020), CCWD Kit Fox Monitoring prior to and after 2017, and CSVRA camera records (State Parks) from 2014_2016 could provide additional information (Table 1).

Literature Cited

EB Stewardship Network. 2022. EHA EB Stewardship Network

Sapere Environmental, LLC. 2019. Draft Vasco Road Amphibian Undercrossing Pilot Study. Prepared for East Contra Costa County Habitat Conservancy. Contract No. 2016-16.

Data Sources:

1) EBRPD 2004 to 2015 bat survey database

2) EBRPD 2017 to 2021 bat survey database

3) EBMUD Mammal Database

4) Carnegie SVRA (2014, State Parks)

5) Post-Fire Monitoring Study (2021, EBRPD)

Table 1: Camera trapping studies, camera number (cameras with records), date range for cameras, and date range for cameras with records for analysis, Network Partner Stewardship Lands, Area of Focus, California.

Area of Focus	***Agency***	***Study***	***Cam_no.***	***date range***	***records_analysis***	***Indicator***
East Bay Hills	EBRPD	Carnivore Research (Tilden Sibley)	(48)	2016_2020	2016_2020	Mesocarnivores
East Bay Hills	EBMUD	EBMUD Ad Hoc	5	2010_2020	Not included	Mammals
East Bay Hills	EBRPD	Panthera	18	2021_2021	Not included	Mammals
		Total in East Bay Hills (no. analysis)	***71 (48)***			
Mount Diablo	EBRPD	Carnivore Research (ECCC)	(10)	2019_2020	2019_2020	Mesocarnivores
Mount Diablo	State Parks	Felidae (Mount Diablo State Park)	10 (6)	2019_2021	2020_2020	Mammals
Mount Diablo	EBRPD	Post-fire monitoring	40	2020_2021	Not included	Mammals
Mount Diablo	CCWD	CCWD Mitigation Lands, Kit fox monitoring	(15)	2014_2020	2017_2020	Mesocarnivores
		Total in Mount Diablo (no. analysis)	***75 (31)***			
Mount Hamilton	State Parks	Large Mammal Occupancy Study	(27)	2017_2021	2017_2021	Mammals
Mount Hamilton	State Parks	Large Mammal Occupancy Study	unknown	2014_2016	Not included	Mammals
Mount Hamilton	EBRPD	Carnivore Research (Sunol Ohlone)	(9)	2012_2018	2012_2018	Mesocarnivores
Mount Hamilton	EBRPD	Carnivore Research (Sunol Ohlone)	9	2018_2020	Not included	Mesocarnivores
Mount Hamilton	EBRPD	Panthera	81	2020_2021	Not included	Mammals
Mount Hamilton	CCWD	CCWD Mitigation Lands, Kit fox monitoring	(18)	2014_2020	2017_2020	Mesocarnivores
		Total in Mount Hamilton (no. analysis)	***144 (54)***			
All Areas		**Total cameras (no. analysis)**	**290 (133)**			

Table 2a: Detections of Indicator Species [bobcat, coyote, gray fox, puma and ground squirrel (GRSQ)], number of camera (no. cams), date range (range) and number of years, Network Stewardship Lands, Area of Focus, California [CR (T-S) = Carnivore Research (Tilden-Sibley), CR (ECCC) = Carnivore Research (ECCC), FEL = Felidae, KFM = Kit fox monitoring, LMS = Large Mammal Study, OHWICO = Carnivore Research (Sunol Ohlone), OHWIow = Carnivore Research (Sunol Ohlone)]

AGENCY	AofF/Park10	Study	Indicator Species								
			BOBCAT	COYOTE	GRAY FOX	PUMA	GRSQ	TOTAL	no. cams	range	no yrs
EBRPD	Sibley	*CR(T-S)*	620	2,203	997	56	nr	3,876	16	2016_2020	5
EBRPD	Tilden	*CR(T-S)*	661	7,689	1,255	12	nr	9,617	32	2016_2020	5
EBMUD	EBProp	OBS	32	49	7	23	4	111	Obs.	all years	n/a
EBMUD	LAFRES	OBS	2	1	0	7	0	10	Obs.	all years	n/a
EBMUD	SPRES	OBS	3	0	1	3	0	7	Obs.	all years	n/a
	East Bay Hills	***total***	***1,318***	***9,942***	***2,260***	***101***	***4***	***13,713***	***48***		
EBRPD	CLRA	*CR(ECCC)*	379	1,057	6	0	0	1,442	2	2019_20	2
EBRPD	MOTE	*CR(ECCC)*	213	824	53	0	0	1,090	6	2019_20	2
EBRPD	ROVA	*CR(ECCC)*	17	125	0	0	0	142	2	2019	1
SP	Mt Diablo	*FEL*	264	903	42	0	0	1,209	6	2020	1
CCWD	AA HMU	*KFM*	1	71	0	0	37	72	4	2017_2020	4
CCWD	DVE HMU	*KFM*	1	32	0	0	34	33	2	2017_2020	4
CCWD	DVW HMU	*KFM*	1	28	0	0	3	29	4	2017_2020	4
CCWD	LV HMU	*KFM*	7	32	0	0	0	39	2	2017_2020	4
CCWD	MH HMU	*KFM*	18	39	0	0	28	57	3	2017_2020	4
	Mount Diablo	***total***	***901***	***3,111***	***101***	***0***	***102***	**4,113**	***31***		
CCWD	CH HMU	*KFM*	2	90	0	0	6	92	14	2017_2020	4
CCWD	GLA HMU	*KFM*	3	72	0	0	47	75	4	2017_2020	4
SP	CSVRA	*LMS*	345	517	242	116	81	978	27	2017_2021	4
EBRPD	Ohlone	*OHWICO*	430	40	1269	409	0	879	5	2012_2018	7
EBRPD	Ohlone	*OHWIow*	757	1,290	421	125	0	2,172	4	2012_2018	7
	Mount Hamilton	***total***	***1,537***	***2,009***	***1,932***	***650***	***134***	**6,128**	***54***		
	Grand Total		***3,756***	***15,062***	***4,293***	***751***	***240***	***23,862***	***112***		

Park codes: EBProp = EBMUD Property; LAFRES = Lafayette Reservoir; SPRES = San Pablo Reservoir; CLRA = EBRPD Clayton Ranch; MOTE = EBRPD Morgan Territory; ROVA = EBRPD Round Valley; Mt Diablo = Mount Diablo State Parks; AA HMU = Altamount HMU; DVE = Deer Valley East; DVW = Deer Valley West; LV HMU = Los Vaqueros HMU; MH HMU = Mountain House HMU; CH HMU = Corrale Hollow HMU; CSVRA = California State Vehicular Recreation Area; GLA HMU = Grant Line HMU; Ohlone = EBRPD Ohlone Wilderness.

Table 2b: Detections of Indicator Species (badger, ringtail, and woodrat) and number of camera (no. cams), date range (range) and number of years, Network Stewardship Lands, Area of Focus, California

AGENCY	AofF/Park	Study	BADGER	RINGTAIL	WOODRAT	TOTAL	no. cams	range	no yrs
	East Bay Hills								
EBRPD	Sibley	*CR(T-S)*	0	0	0	0	16	2016_2020	5
EBRPD	Tilden	*CR(T-S)*	0	0	0	0	32	2016_2020	5
EBMUD	EBProp	OBS	4	1	59	64	Obs.	all years	
EBMUD	LAFRES	OBS	0	0	23	23	Obs.	all years	
EBMUD	SPRES	OBS	0	0	1	1	Obs.	all years	
	EB	***total***	***4***	***1***	***83***	88	***48***		
	Mount Diablo					0			
EBRPD	CLRA	*CR(ECCC)*	0	0	0	0	2	2019_20	2
EBRPD	MOTE	*CR(ECCC)*	0	0	0	0	6	2019_20	2
EBRPD	ROVA	*CR(ECCC)*	0	0	0	0	2	2019	1
SP	Mt Diablo	*FEL*	0	0	0	0	6	2020	1
CCWD	AA HMU	*KFM*	1	0	0	1	4	2017_2020	4
CCWD	DVE HMU	*KFM*	7	0	0	7	2	2017_2020	4
CCWD	DVW HMU	*KFM*	2	0	0	2	4	2017_2020	4
CCWD	LV HMU	*KFM*	0	0	0	0	2	2017_2020	4
CCWD	MH HMU	*KFM*	10	0	0	10	3	2017_2020	4
	MD	***total***	***20***	0	0	20	***31***		
	Mount Hamilton					0			
CCWD	CH HMU	*KFM*	2	0	0	2	4	2017_2020	4
CCWD	GLA HMU	*KFM*	1	0	0	1	4	2017_2020	4
SP	CSVRA	*LMS*	0	0	0	0	27	2017_2021	4
EBRPD	Ohlone	*OHWICO*	0	0	61	61	5	2012_2018	7
EBRPD	Ohlone	*OHWIow*	0	0	0	0	4	2012_2018	7
	MH	***total***	***3***	***0***	***61***	64	***54***		
	Grand Total		***27***	***1***	***144***	172	***133***		

Table 3: Detections and Non-detections for Indicator Species and proportion occupied in Monitored Parks/Land Units, Stewardship Lands, California (GRSQ = California ground squirrel)

Subregion	Agency	PARK	Park Code	Badger	Bobcat	Coyote	Gray fox	GRSQ	Puma	Ringtail	Woodrat
East Bay Hills	EBMUD	EBMUD Property	EBProp	1	1	1	1	1	1	1	1
East Bay Hills	EBMUD	Lafayette Reservoir	LAFRES	0	1	1	0	0	1	0	1
East Bay Hills	EBRPD	Sibley Volcanic	Sibley	0	1	1	1	0	1	0	0
East Bay Hills	EBMUD	San Pablo Reservoir	SPRES	0	1	0	1	0	1	0	1
East Bay Hills	EBRPD	Tilden (Nature)	Tilden	0	1	1	1	0	1	0	0
Mount Diablo	CCWD	Altamont Subunit	AA HMU	1	1	1	0	1	0	0	0
Mount Diablo	EBRPD	Clayton Ranch	CLRA	1	1	1	1	0	0	0	0
Mount Diablo	CCWD	Deer Valley East	DVE HMU	1	1	1	0	1	0	0	0
Mount Diablo	CCWD	Deer Valley West	DVW HMU	1	1	1	0	1	0	0	0
Mount Diablo	CCWD	Los Vaqueros	LV HMU	0	1	1	0	0	0	0	0
Mount Diablo	CCWD	Mountain House Subunit	MH HMU	1	1	1	0	1	0	0	0
Mount Diablo	EBRPD	Morgan Territory	MOTE	0	1	1	1	0	0	0	0
Mount Diablo	SP	Mount Diablo State Park	Mt Diablo	0	1	1	1	0	0	0	0
Mount Diablo	EBRPD	Round Valley	ROVA	0	1	1	0	0	0	0	0
Mount Hamilton	CCWD	Corral Hollow HMU	CH HMU	1	1	1	0	1	0	0	0
Mount Hamilton	SP	Carnegie State Vehicular Recreation Area	CSVRA	0	1	1	1	0	1	0	0
Mount Hamilton	CCWD	Grant Line Subunit	GLA HMU	1	1	1	0	1	0	0	0
Mount Hamilton	EBRPD	Ohlone Wilderness	Ohlone	0	1	1	1	0	1	0	1
		Total detections		***8***	***18***	***17***	***9***	***7***	***7***	***1***	***4***
		PROPORTION OCCUPIED		**0.44**	**1.00**	**0.94**	**0.50**	**0.39**	**0.39**	**0.06**	**0.22**

Table 4: Detections (tallied records) for each year (time series), Network Partner records, Stewardship Lands, Area of Focus, California

a) Bobcat

Subregion	**BOBCAT**										
	2012	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*-*	*Grand Total*
East Bay Hills											
EBProp	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	32	32
LAFRES	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	2	2
Sibley					51	126	15	273	155	n/a	620
SPRES	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	3	3
Tilden					109	178	9	296	69	n/a	661
Total					***160***	***304***	***24***	***569***	***224***	***37***	***1318***
Mount Diablo											
AA HMU						1	0	0	0	n/a	1
CLRA								154	225	n/a	379
DVE HMU						0	1	0	0	n/a	1
DVW HMU						1	0	0	0	n/a	1
LV HMU						0	2	3	2	n/a	7
MH HMU						0	1	4	13	n/a	18
MOTE								49	164	n/a	213
Mt Diablo									264	n/a	264
ROVA								17		n/a	17
Total						***2***	***4***	***227***	***668***	***n/a***	***901***
Mount Hamilton										n/a	
CH HMU						0	2	0	0	n/a	2
CSVRA						99	109	60	77	n/a	345
GLA HMU						0	0	3	0	n/a	3
Ohlone	1	11	54	160	367	444	150			n/a	1187
Total	***1***	***11***	***54***	***160***	***367***	***543***	***261***	***63***	***77***	*n/a*	***1537***
Grand Total	1	11	54	160	527	849	289	859	969	37	3756

b) Coyote

Subregion	**COYOTE**										
Park	2012	2013	2014	2015	2016	2017	2018	2019	2020	-	Grand Total
East Bay Hills											
EBProp	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	49	49
LAFRES	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1	1
Sibley					228	623	43	975	334	n/a	2203
Tilden					737	2000	45	4123	784	n/a	7689
EB – total	**n/a**	**n/a**	**n/a**	**n/a**	**965**	**2623**	**88**	**5098**	**1118**	**50**	**9942**
Mount Diablo											
AA HMU						14	19	18	20	n/a	71
CLRA								642	415	n/a	1057
DVE HMU						1	5	14	12	n/a	32
DVW HMU						6	9	3	10	n/a	28
LV HMU						6	5	9	12	n/a	32
MH HMU						10	8	4	17	n/a	39
MOTE								323	501	n/a	824
Mt Diablo – total									903	n/a	903
ROVA								125		n/a	125
MD						**37**	**46**	**1138**	**1890**	n/a	**3111**
Mount Hamilton											
CH HMU						12	19	21	38	n/a	90
CSVRA						164	194	56	103	n/a	517
GLA HMU						9	23	20	20	n/a	72
Ohlone	0	42	104	111	482	423	168			n/a	1330
MH – total	**0**	**42**	**104**	**111**	**482**	**608**	**404**	**97**	**161**	n/a	**2009**
Grand Total	0	42	104	111	1447	3268	538	6333	3169	50	15062

c) Gray fox

Subregion	GRAY FOX										
Park	2012	2013	2014	2015	2016	2017	2018	2019	2020	-	Grand Total
East Bay Hills											
EBProp	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	7	7
Sibley					165	350	26	435	21	n/a	997
SPRES	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1	1
Tilden					257	486	53	450	9	n/a	1255
EB -total					**422**	**836**	**79**	**885**	**30**	**8**	**2260**
Mount Diablo											
CLRA								1	5	n/a	6
MOTE								41	12	n/a	53
Mt Diablo									42	n/a	42
MD – total								**42**	**59**	n/a	**101**
Mount Hamilton										n/a	
CSVRA						99	83	26	34	n/a	242
Ohlone	2	368	155	590	352	193	30			n/a	1690
MH – total	**2**	**368**	**155**	**590**	**352**	**292**	**113**	**26**	**34**	n/a	**1932**
Grand Total	2	368	155	590	774	1128	192	953	123	8	4293

d) Badger

BADGER					
Subregion/Park	**2017**	**2019**	**2020**	**2021**	**Grand Total**
EBProp	n/a	n/a	n/a	1	1
East Bay Hills				***1***	***1***
AA HMU	0	0	1	n/a	1
DVE HMU	0	1	1	n/a	2
DVW HMU	1	0	1	n/a	2
MH HMU	0	1	1	n/a	2
Mount Diablo	***1***	***2***	***4***		***7***
CH HMU	0	0	1	n/a	1
GLA HMU	0	0	1	n/a	1
Mount Hamilton	***0***	***0***	***2***	***0***	***2***
Grand Total	**1**	**2**	**6**	**1**	**10**

e) Puma

Subregion	**PUMA**										
Park	2012	2013	2014	2015	2016	2017	2018	2019	2020	-	Grand Total
East Bay Hills											
EBProp	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	23	23
LAFRES	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	7	7
Sibley					5	37	6	3	5	n/a	56
SPRES	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	3	3
Tilden					6	2	0	4	0	n/a	12
EB – total					**11**	**39**	**6**	**7**	**5**	**33**	**101**
Mount Hamilton											
CSVRA						48	32	17	19	n/a	116
Ohlone	6	7	18	48	126	257	72	0	0	n/a	534
MH – total	**6**	**7**	**18**	**48**	**126**	**305**	**104**	**17**	**19**	**n/a**	**650**
Grand Total	6	7	18	48	137	344	110	24	24	33	751

f) Ground squirrel

Subregion	GROUND SQUIRREL					
Park						
	2017	2018	2019	2020	-	Grand Total
East Bay Hills						
EBProp	n/a	n/a	n/a	n/a	4	4
MD	18	20	21	43	n/a	102
AA HMU	7	9	9	12	n/a	37
DVE HMU	4	6	8	16	n/a	34
DVW HMU	2	1	0	0	n/a	3
MH HMU	5	4	4	15	n/a	28
EB	**36**	**40**	**42**	**86**	**4**	**204**
Mount Hamilton						
CH HMU	0	0	0	6	n/a	6
CSVRA	7	46	24	4	n/a	81
GLA HMU	10	6	10	21	n/a	47
MH	**17**	**52**	**34**	**31**	**n/a**	**134**
Grand Total	***35***	***72***	***55***	***74***	***4***	***240***

g) Woodrat

Subregion	**WOODRAT**							
Park	2013	2014	2015	2016	2017	2018	-	Grand Total
East Bay Hills								
EBProp	n/a	n/a	n/a	n/a	n/a	n/a	59	59
LAFRES	n/a	n/a	n/a	n/a	n/a	n/a	23	23
SPRES	n/a	n/a	n/a	n/a	n/a	n/a	1	1
EB							**83**	**83**
Mount Hamilton								
Ohlone	9	3	5	23	20	1	n/a	61
MH	**9**	**3**	**5**	**23**	**20**	**1**	n/a	**61**
Grand Total	9	3	5	23	20	1	83	144

APPENDIX. H. GROUND SQUIRREL RESEARCH REPORT

California ground squirrel presence, aerial extent (active), and abundance within the East Bay Regional Park District Lands in the Area of Focus for the Ecological Health Assessment for East Bay Stewardship Network

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List of Tables

List of Figures

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Introduction

The California ground squirrel (*Otospermophilus beecheyi*) is likely a 'keystone species' (Kotliar *et al*. 1999; Smith and Foggin 1999; Lai and Smith 2003) — a species whose impact on its community is disproportionately large relative to abundance (Paine 1969; Power *et al*. 1996) as well as performing a variety of functions, and, in this sense, ground squirrels are considered 'ecosystem engineers'(Wright and Jones 2006). In the San Francisco East Bay region, the California ground squirrel is considered common and widespread; however, assessing current distribution and if the populations are stable or declining and if they are shrinking or expanding extent has not been assessed. As with many common species, little consideration is given to assessing abundance despite changing climatological conditions, habitat degradation, and poisoning as ground squirrel is designated as a pest. Recent anecdotal reports of declining ground squirrel numbers by reputable biologists have raised concern about how ground squirrels are currently doing in this part of their geographic range.

Of the 905 sq km Area of Focus for the East Bay Ecological Health Assessment, 455 sq km (50%) are grasslands and 258.9 sq km (29%) are oak woodland; both habitats ground squirrels prefer. Each subregion in the Areas of Focus have land units with grasslands (East Bay Hills has 49 land units with over 111.5 sq km of grasslands, Mount Hamilton has 24 land units with over 146 sq km of grasslands, and Mount Diablo has 27 land units with over 196 sq km of grasslands); we currently do not have information on ground squirrel presence or absence even at the land unit level. The EBRPD lands include 208 sq km of grasslands in 65 parks. Additionally, we do not understand the aerial extent of ground squirrel presence (burrow complexes) and if those burrow complexes are currently active, and finally, we do not have an abundance metric or baseline upon which to use as a reference to understand if ground squirrel populations are stable, declining or increasing.

Table 1: Subregion, number of Parks (units) and amount of grasslands (sq km) in the East Bay Ecological Health Assessment Area of Focus

Subregion	EBRPD Parks	Grasslands
East Bay Hill	37 units	73 sq km
Mount Diablo	22 units	99.6 sq km
Mount Hamilton	6 units	36.2 sq km

Because ground squirrels are not listed as a special-status species [although they are assessed in some cases related to listed species such as the San Joaquin kit fox (*Vulpes macrotis mutica*), the California salamander (*Ambystoma californiense*), and burrowing owl (*Athene cunicularia*] rigorous assessments of their population and distribution are not conducted.

Despite being diurnal, ground squirrels spend a considerable amount of time underground and their burrows persist on the landscape even after they are absent. There is extensive research on burrowing species including the California ground squirrel – despite this, burrowing mammals remain a challenging species to estimate population status. Our goal is to create a baseline for several metrics to track into the future to understand if the California ground squirrels are doing well by 1) documenting occurrence in land units in each area of focus, 2) mapping aerial extent of presence, 3) determining percent active or inactive in subset of mapped areas, and 4) identifying sentinel ground squirrel monitoring sites in each area of focus to be surveyed annually to determine trends in activity and abundance.

Reliably measuring wildlife abundance and having baselines against which to measure change provide land managers with information to adaptively manage open space to meet goals for wildlife and the health of the ecosystem. Land managers and stakeholders including the public are becoming more proactive in applying new tools to better understand how local and regional ecosystems are faring. Indeed, the effect of recreationalists and other anthropogenic influences on wildlife in open space has become a subject of great interest (Barja *et al.* 2011, Cassirer *et al.* 1992, Gaynor *et al.* 2018, Reilly *et al.* 2017, Ordenana *et al.* 2010, Wang *et al.* 2015, Whittington *et al.* 2015 and Wilmers *et al.* 2013). The paradigm has shifted away from assuming protected open space will de facto conserve wildlife and that a more thoughtful, empirically based approach is required to ensure this outcome.

Methods

Study Area and Setting

The East Bay region in the San Fracisco Bay Area support grasslands and oak woodland suitable for ground squirrels. EBRPD lands with grasslands located in the Ecological Health Assessment were identified. Stewardship Network including the EBRPD staff were queried about where ground squirrels have been observed in the past few years. This information was used to target candidate parks to survey.

Driving and walking transects

Driving and walking transects were conducted to survey parks for the California ground squirrel to document presence and activity. Tracks and observations were recorded and areas where ground squirrel were and were not observed using a hand-held GPS recording tracks and locations with attributes.

Sentinel Sites

The Ecological Health Assessment Area of Focus has three subregions, the East Bay Hills, Mount Diablo, and Mount Hamilton. Sentinel sites were located in 6 EBRPD Parks: Garin, Briones, Brushy Peak, Morgan Territory, Del Valle, and Sunol (see Fig. 1); two parks are located in each subregion.

Max Counts

To estimate the density of California ground squirrels, we conducted complete visual counts on each designated 4ha plot located within the six Sentinel Sites (Fig. 1). Visual counts conducted over at least three days produce the best correspondence to mark-recapture population estimates (Fagerstone 1984; Severson & Plumb 1998). Peak abundance of ground squirrels occurs after litters of pups emerge from natal burrows (May through June) but before adults initiate estivation belowground (in July; see Fig. 1. Counts were scheduled to coincide with peak activity both seasonally and daily. Since, weather affects California ground squirrel activity patterns (particularly factors like light intensity and air temperature), counts were conducted only during morning hours when squirrels were above ground actively foraging and socializing. Population closure was assumed for the counting period.

Within each Sentinel Site, a count plot was designated based on the abundance of California ground squirrels in a location with good visibility. Counts were conducted within an area approximately four hectares (10 acres or x sq m) in size. The observer sat quietly (on the ground or small stool) at an observation point (hillside, rock outcrop, truck bed) with a clear unobstructed view of the count area. High quality optics (10x40 Zeiss binoculars and Nikon field scope 20-45 zoom lens with tripod) were utilized to view activity without disturbing ground squirrels. Upon reaching the observation point, the observer waited quietly for 15 minutes before commencing the count. Generally three but sometimes four scans were made at 15-30 minute intervals during the peak morning (0800-1200) period for 3 consecutive days. A fourth scan was initiated if a predator or the level of recreation activity disrupted an earlier count by sending a large portion of the ground squirrels underground. Each count consisted of a systematic scan tallying individual ground squirrels beginning at one edge of the study area and continuing to the other. During successive scans, the location of litters of young squirrel pups became apparent so individual litters were opportunistically counted. No portion of the area was scanned more than once (Error of double counts = 2.5%, Fagerstone 1984).

Distance Transects

We conducted line transect surveys using distance sampling (Buckland *et al*. 2001) in the 6 sentinel sites (Fig. 1). We walked north south transects at approximately 50 m intervals.

We recorded burrows and burrow clusters (burrows less than 5m apart); the methods for burrow cluster data collection were modeled after Townsend 2005 in order to estimate burrow and burrow cluster density.

Distance sampling along line transects was conducted using hand-held GPS to navigate along the transects and to record location data. Transect start and end coordinates were recorded. One or two individuals walked the transect scanning primarily within 20 m of the transect for burrows. When two individuals walked together, one was an observer and one was a data recorder.

Burrow attributes

When a burrow was detected from the transect, the observer left the transect to collect burrow location and record burrow and burrow cluster attribute. Burrows were also placed in various size classes; less than 2" in diameter were reported but were not considered suitable for ground squirrel (however, that does not preclude that ground squirrels may use burrows of that size) and ignored if not in a burrow cluster, 2" in diameter, burrows > 2 to 7" and > 7"(may also be considered a canid or badger den).

A burrow cluster (our sampling unit) was defined as a group of burrows that were within 5 m of one another. For each burrow and burrow cluster, we measured burrow number, burrow size, and the presence of digging, tracks (consistent in size and shape with ground squirrel), scat (old or fresh, type and size), debris (in entrance), ground squirrel, and ground squirrel alarm call.

Distance Analysis

The software program DISTANCE (v. 5.0; Thomas *et al*. 2005) was used to analyze the data collected from the line transect survey in order to estimate densities of active and inactive burrow clusters (Buckland *et al*. 2001).

Density estimates of clustered objects (D_s) and individuals (*D*) were estimated using the equations $\hat{D}_s = \frac{n\hat{f}(0)}{2L}$ and $\hat{D} = \frac{n\hat{f}(0)\hat{E}(s)}{2L}$, respectively (Buckland *et al*. 2001): Where *n* is the number of objects detected, *L* is the total length of the line, $\hat{f}(0)$ is the estimated probability detection function of the perpendicular distances evaluated at zero, $\hat{E}(s)$ is the estimated expected cluster size, and $\hat{D}_s$ and $\hat{D}$ is the estimated density of clusters and individuals, respectively (objects km^2).

Final model selection was based on the lowest AIC (Akaike's Information Criterion) value (Burnham and Anderson 2002). Goodness of fit (χ^2) was used to assess the quality of distance data and the general shape of the detection function. We right truncated the width of the maximum sighting distance (w) at least 5% in order to improve model fit if warranted.

Distance sampling methods assume that line transects are located randomly with respect to the distributions of the units of observation (avoids the assumption that animals or burrows are randomly distributed), that all objects are detected on the line, no movement prior to detection and accurate measurements of distances to the observations.

Results

Transects

Driving and walking transects were conducted in some parks to assess the presence of California ground squirrels and to select areas for the Sentinel Sites. Walking and/or driving transects were conducted between May 11 and June 22, 2021. East Bay Regional Parks and/or Open Space that were surveyed included Brushy Peak, Morgan Territory, Round Valley, Sunol, Garin, Dry Creek and Pioneer, Las Trampas, Bear Creek and Happy Valley in Briones, Del Valle, and Alhambra at Briones. Routes and ad hoc records of ground squirrel observations were recorded. Ground squirrels were observed in all these parks except Las Trampas Regional Wilderness (see Fig. x). [IN PROCESS]

Sentinel Sites

Max Counts

Visual counts were conducted from May 18 to June 10, 2021. Each Sentinel Site was counted for three consecutive days to obtain the highest number of individual squirrels counted over that period ("the maximum count"). Using this method, Sentinel Sites can then be ranked in order of abundance by site allowing comparison with repeated counts in the future and with historic data of estimated density (California ground squirrels/ha or per sq km).

Table 2: Maximum counts (Max #) and number of litters (Max# of litters) of California ground squirrels at each sentinel site, East Bay Regional Park District, CA (May and June, 2021)

Ranking	Subregion	Park	Max #11	Individuals/ ha	Max # of litters12
1	Mount Hamilton	Sunol	210	52.5	15
2	East Bay Hills	Briones	114	28.5	13
3	East Bay Hills	Garin	97	24.25	12
4	Mount Hamilton	Del Valle	96	24	10
5	Mount Diablo	Morgan Territory	93	23.25	14
6	Mount Diablo	Brushy Peak	88	22	12
Mean			***116***	***29***	***12.66***

Count numbers varied somewhat by Sentinel Site location (range = 88 – 210; x = xx). Overall density ranged from 22 at Brushy Peak to a high of 52 squirrels/ha (x per sq km and x per sq km, respectively) at Sunol with a mean estimated density of 29 squirrels/ha (x per sq km). Litter counts, although not the focus here, correlated with the ranking of site abundance. Young of the year constituted the most numerous age group for this count and represented the majority of the count total.

The frequency of both aerial and terrestrial predators was highest at Brushy Peak (20 foraging attempts by Golden Eagle, Red-tailed Hawk and Common Raven and 5 coyotes), followed by Sunol (12 Golden Eagle, Prairie Falcon, and Common Raven and no coyote) and Morgan territory (11 Golden Eagle, Prairie and Peregrine Falcon, Common Raven and no coyote). Fewer predators were recorded at Briones (4 Red-tailed Hawk, Cooper's Hawk and no coyote but numerous dogs), Del Valle (4 Golden

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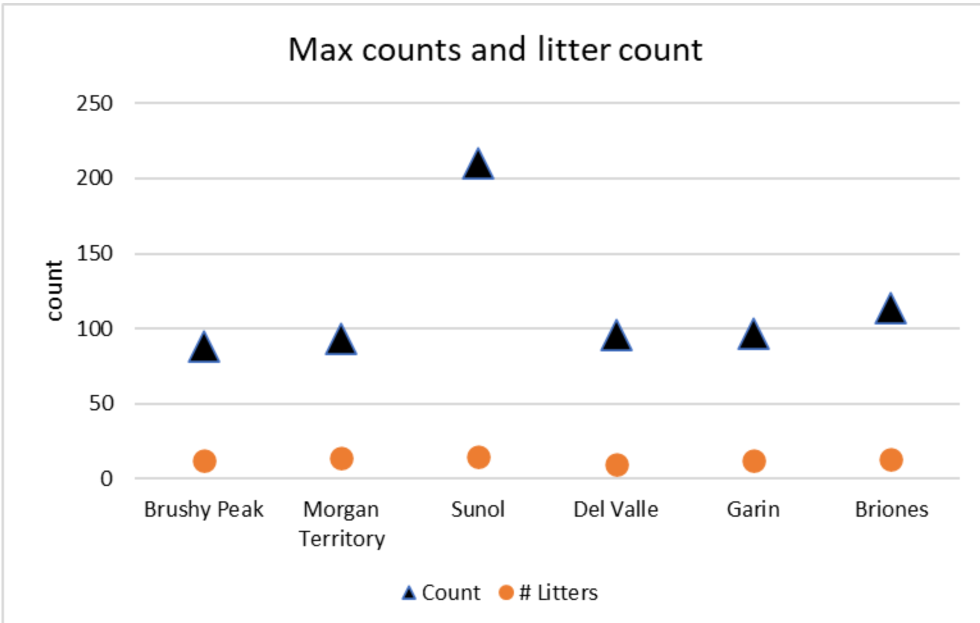
11 Maximum # of squirrels counted is the largest number of individual squirrels recorded during visual counts within the four-hectare Sentinel Site.

12 Maximum # of litters observed is the largest number of litters recorded during visual counts within the four-hectare Sentinel Site. A litter is defined as a group of similar aged squirrel pups associated with one adult female.

Eagle, Red-tailed Hawk and one coyote) and Garin (3 Red-tailed Hawk, Common Raven and one coyote).

Figure 3: Maximum individual and litter counts for each sentinel site, EBRPD, California. (May and June 2021)



Distance sampling

Total transect length ("effort") ranged from 439 to 578 m and the number of transects ranged from 2 to 5 per sentinel site. Transect width used in the analysis varied from 14 to 26 m on a transect side (Table 4).

Table 4: Effort, number of transects, width, and number of observations (no. obs) for distance sampling in the Sentinel Sites, Alameda and Contra Costa counties, California (May and June 2021)

Area of Focus	Park	Effort (m)	no. transects	Width (m)	no. obs
Mount Diablo	**Brushy Peak**	**532**	**2**	**26**	**47**
Mount Diablo	**Morgan Territory**	**445**	**3**	**20**	**36**
Mount Hamilton	**Sunol**	**543**	**4**	**23**	**52**
Mount Hamilton	**Del Valle**	**480**	**5**	**14**	**65**
East Bay Hills	**Garin**	**439**	**3**	**22**	**51**
East Bay Hills	**Briones**	**578**	**3**	**19**	**50**

Burrow density estimate (D) ranged from 6,852 at Brushy Peak to a high of 36,350 burrows per sq km at Briones and burrow cluster density estimate (DS) ranged from 3,405 at Brushy Peak and a high of 9,230 burrow clusters per sq km at Garin (Table 4 and Figs. 3 and 4). Brushy Peak and Morgan Territory burrow density estimates were lower (6,852 and 10,590, respectively) when compared to the other four sites (range = 30,082 to 36,350; Fig. 5 and Table 4). The burrow cluster density estimates from Brushy Peak (3,405) and Morgan Territory (3,730) were fewer than, but similar to, the other 4 sites, Sunol, Del Valle, Garin, and Briones, with burrow cluster density estimates that ranged from a low of 6,329 to a high of 9,230. This comparison is comparing density of "burrow complexes," that is, burrows that are closer together and the number of burrows per burrow cluster can vary (see next section for discussion of these results). Brushy Peak burrow cluster density confidence limits were large rendering that estimate not very useful for comparisons; this issue is usually remedied by increasing the number of transects; the Garin site also had large confidence limits for both burrow and burrow cluster density.

Figure 3: Density estimates (burrows per sq km±CI) for each sentinel site, EBRPD, California (May and June 2021)

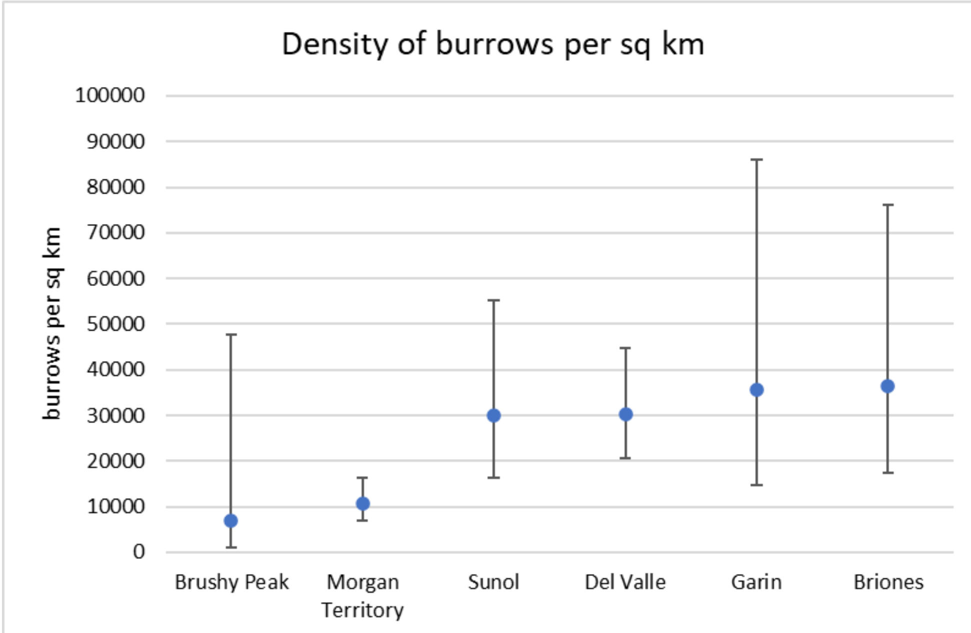
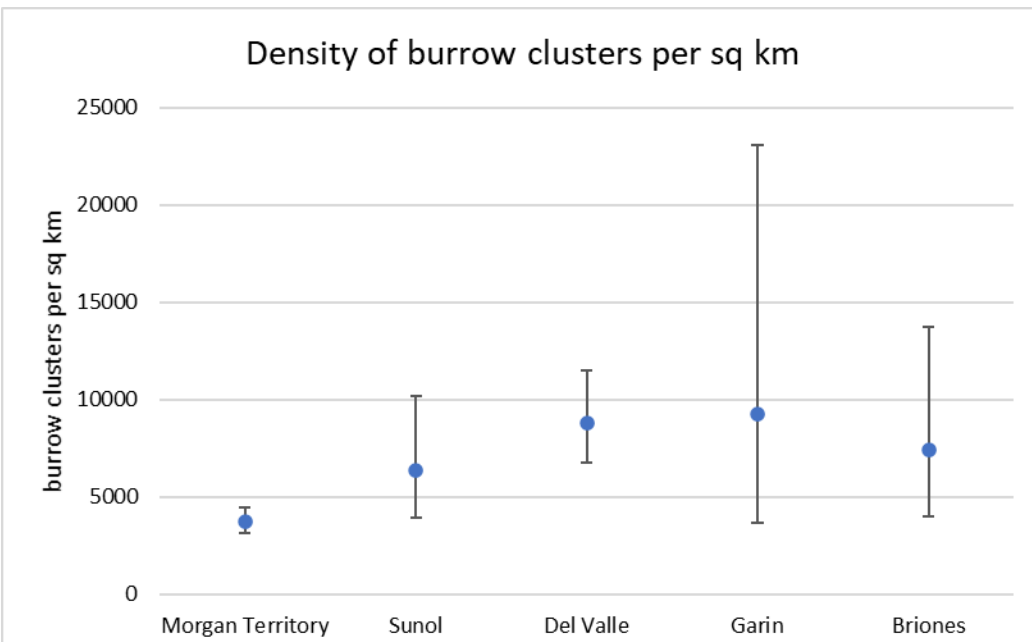


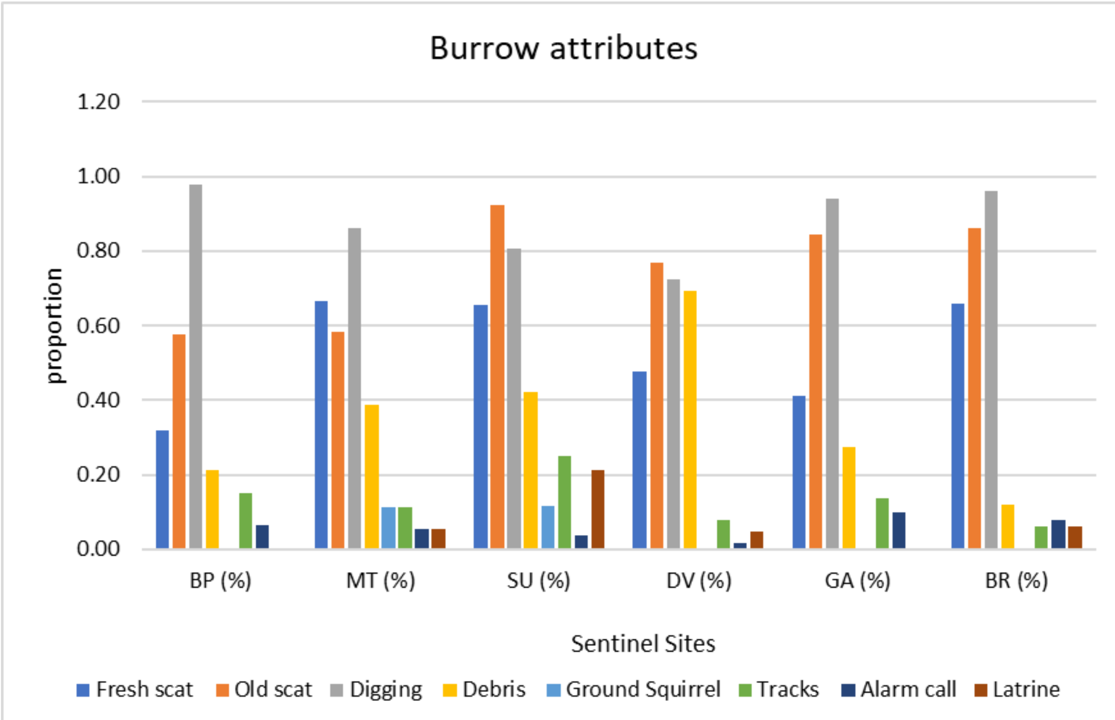
Figure 4: Density estimates (burrow cluster per sq km±CI) for each sentinel site, EBRPD, California (May and June 2021)



Burrow and burrow cluster attributes

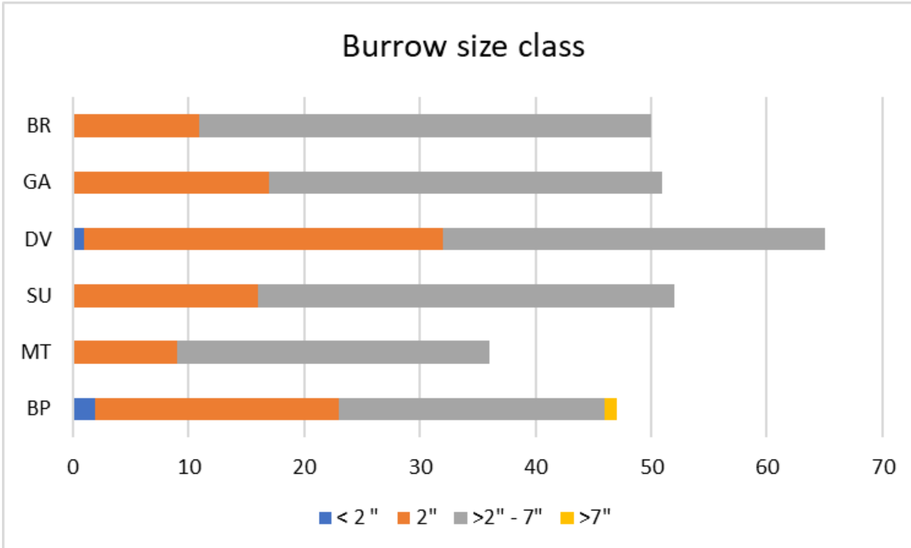
Burrow attributes can indicate activity and inactivity; fresh scat, alarm calls, and observation of a ground squirrel indicate likely active and, conversely, digging and debris in entrance may indicate inactivity. Burrows can persist on the landscape for variable periods of time depending on use, soil type, and soil moisture.

Figure 5: Burrow attributes (proportion of total burrows) from each Sentinel Site (BP = Brushy Peak, MT = Morgan Territory, SU = Sunol, DV = Del Valle, GA = Garin, and BR = Briones), EBRPD, California (May and June 2021)



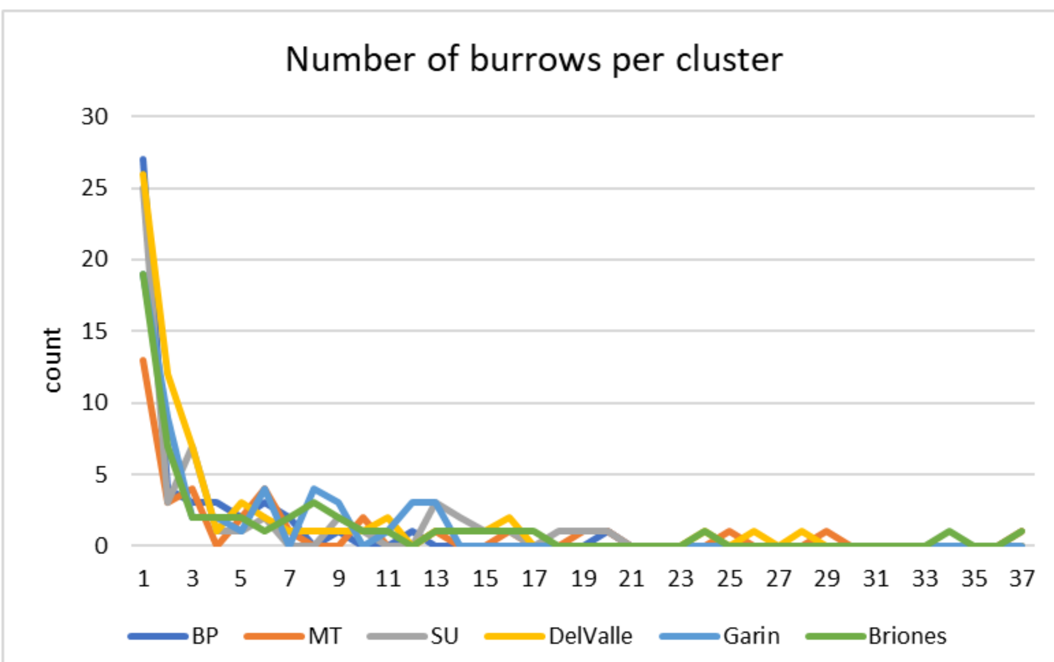
Burrow size class varied by site and there was no clear relationship between burrow size classes and max counts (Fig. 3). Generally, burrows less than 2 inches and greater than 7 inches are considered not suitable for ground squirrels, but they can use them none the less. The 2-inch size class seemed fairly prevalent and could realistically be put in a 2 inch or greater group. Brushy Peak had burrows over 7" in diameter with clear sign of badger use. Measuring change over time of proportion of available burrows in various size classes can characterize suitability of a site for ground squirrel and other wildlife that may be using burrows (for example, burrows greater than 5 or 6 inches are suitable for mesocarnivores such as the endangered San Joaquin kit fox.

Figure 6: Count of each size class (less than 2" diameter, 2" diameter, 2 to 7" diameter, and greater than 7" diameter) for Sentinel Site, EBRPD, California (May and June 2021)



Burrow cluster size varied from 1 to 37 burrows; the greatest frequency of burrow cluster size was generally less than 14 burrows (Fig. 7); several sites had larger cluster such as Briones, Del Valle and Morgan Territory.

Figure 7: Frequency of burrow cluster size for each Sentinel Site, EBRPD, California



Conclusion

Several factors have the potential to enhance or diminish the total number of California ground squirrels counted, primarily visibility, predator presence and recreation activity. Although the count methodology helps even out any effect these factors might play, it is important to be aware of these factors when setting up plots and analyzing results.

Sentinel Site count plots were set up to maximize visibility of ground squirrels. However, California ground squirrels can be quite cryptic when they are not moving since their coat color blends well with both the soil and dry vegetation. Vegetation dried early in 2021 due to severe drought. As such, in areas where forbs and grasses were higher, such as Del Valle, young pups were difficult to locate when they were still. This may have decreased the total number of observable individuals at this Sentinel site.

The type of predator present within a colony can alternatively increase or decrease counts. Ever vigilant, California ground squirrels produce alarm calls to attract attention to predators and alert kin (Hanson and Coss 1997, Owings 2002). Reaction to an alarm call, however, differs according to the hunting tactic of the approaching predator. Aerial predators attack swiftly from above. This elicits a single note alarm call followed by a swift run to the nearest escape burrow (Owings and Hennessey 1984). For a period of time following a hunting foray by an aerial predator most ground squirrels remain safely underground waiting until the sky is clear. As a result, successive counts may decrease in number for a short period after a foraging attempt. Terrestrial predators also cause squirrels closest to the predator to run to the nearest burrow entrance. But the slower hunting approach of a carnivore like a coyote allows most non-target squirrels to retreat to the safety of a burrow entrance where they emit multi-note vocalizations, sometimes calling continuously (Owings 2002). Such an alert watchful response keeps most ground squirrels aboveground standing upright to view the predator. In this situation, the predator can substantially enhance visibility of individuals resulting in a highly representative maximum count. Predators were encountered at all six Sentinel Sites but the frequency of Golden Eagle forays was highest over Brushy Peak which may have depressed squirrel numbers within specific count periods. Counts at Briones may have been enhanced at times as dogs frequently walked along the trail through the valley below.

Since the EBRPs are a popular destination for recreationists, human activity is also a factor when conducting any type of wildlife survey. Although, recreational activity was not quantified for this study, some Sentinel Site parks were more popular than others. In addition, type of recreation and level of activity likely influence ground squirrel behavior differentially. Counts were conducted in the morning and that may have reduced recreation related disruptions at Sentinel Sites that were more difficult to access, namely Sunol and Morgan Territory where only a few hikers and dog walkers ventured up the trail during weekday mornings. Del Valle and Brushy Peak experienced moderate numbers of hikers, dog walkers and somewhat more cyclists. Garin Park is busy, even early in the morning, yet disturbance was low within the fenced hillside Sentinel site with the exception of a few dog walkers that encouraged ground squirrel chasing. The Briones Alhambra Staging Area appears to be a favorite launch area for all activities including family and solo hikes, dog walking, group and solo cycling. Counts were frequently disrupted as streams of recreationists passed by on parallel trails at the base of the Sentinel Site plot. Again, despite these disruptions, an observer counting individual squirrels repeatedly over several days will capture a representative total maximum number of ground squirrels within that plot.

For each burrow and burrow cluster, we measured burrow number, burrow size, and the presence of digging, tracks (consistent in size and shape with ground squirrel), scat (old or fresh, type and size), debris (in entrance), ground squirrel, and ground squirrel alarm call (see Appendix: Ground Squirrel Research Report for details); results indicated that Morgan Territory (Mount Diablo), Sunol (Mount Hamilton) and Briones (East Bay Hills) had the over 60% of burrows with fresh scat with the remainder sites, Brushy Peak (Mount Diablo), Del Valle (Mount Hamilton), and Garin (East Bay Hills) at less than 50% with fresh scat (see Fig. 5 in Appendix: Ground Squirrel Study). Burrow attributes can indicate activity or inactivity; fresh scat, alarm calls, and observation of a ground squirrel indicate likely active and, conversely, debris in entrance may indicate inactivity, for example. Burrows can persist on the landscape for variable periods of time depending on use, soil type, and soil moisture. Density estimates are reported for burrows and burrow clusters (burrows within 5 m of another).

Burrow density estimate per sq km (D) ranged from 6,852 at Brushy Peak (Mount Diablo) to a high of 36,350 burrows per sq km at Briones (East Bay Hills) and burrow cluster density estimate per sq km (DS) ranged from 3,405 (187 – 62,167; not included in the figure due to this large confidence interval) at Brushy Peak and a high of 9,230 at Garin (Figs. 3 and 4; see Table 4). The Brush Peak density estimate's large confidence intervals can be remedied in future years by increasing the number of transects. The burrow density estimate was lower in the Mount Diablo subregion (6,852 at Brushy Peak and 10,590 at Morgan Territory EBRPD) compared to East Bay Hills and Mount Hamilton (range = 30,082 to 36,350 burrows per sq km). Burrow and burrow cluster density is a measure that characterizes ground squirrel burrow activity from the past and possibly presently. Presumably burrow density will decrease over time with lower density or declining ground squirrel activity; the amount of time it takes for burrows to collapse varies. Therefore, burrow density alone does not necessarily indicate the presence of ground squirrels, nor does it necessarily correlate with in "real time" with ground squirrel density. However, aspects of burrow density can support other measures such as max counts. For example, increasing burrow density with concomitant "active" attributes (fresh scat, recent digging, for example) can indicate increased ground squirrel activity and density. Burrow density with reported attributes (that can indicate active and inactive) and max counts can be used over time to understand if ground squirrel numbers at the sentinel sites are stable, decreasing and increasing. Burrow density is reported as a per square km as is standard, but sentinel sites were intentionally picked for their level of activity (moderate to high); we will use this metric for comparison in subsequent years not necessarily to indicate density for the park. Ground squirrel populations are generally patchily distributed in their environment and vary over time. By using repeatable protocols to gather data, we hope that this approach will provide an early warning for any sustained or catastrophic declines in California ground squirrels in the East Bay Regional Park District Lands. This information will allow a quick response to understand how widespread this decline is, identify possible reasons for the decline and provide intervention to support ground squirrel populations through grassland stewardship and actions to address the cause of the declines.

Literature Cited

Barja, I., Silván, G., Martínez-Fernández, L. and J. C. Illera. 2011. Physiological stress responses, fecal marking behavior, and reproduction in wild European pine martens (*Martes martes*). *Journal of Chemical Ecology* 37:253–259.

Buckland, S.T., Anderson D.R., Burnham K.P., Laake, J.L., Borchers, D. L., and L. Thomas. 2001. *Introduction to Distance Sampling: Estimating abundance of biological populations*. Oxford University Press.

Burnham, K.P. and D. R. Anderson. 2002. *Model Selection and Multimodal Inference: practical information – theoretic approach*, 2nd Ed. Springer-Verlag, New York.

Cassirer, E.F., Freddy, D.J. and E.D. Ables. 1992. Elk responses to disturbance by country-country skiers in Yellowstone National Park. Wildlife Society Bulletin 20: 375 – 381.

Fagerstone, K. A. 1984. An evaluation of visual counts for censusing ground squirrels. *Vertebrate Pest Control, 4th Symposium:* 239-246.

Gaynor, K.M., Hojnowski, C.E., Carter, N.H., and J. Brashares. 2018. The influence of human disturbance on wildlife nocturnality. *Science* 360:1232 -1235.

Hanson, M. T. and R. G. Coss. 1997. Age differences in the response of California ground squirrels (*Spermophilus beecheyi*) to avian and mammalian predators. *Journal of Comparative Psychology* 111: 174-184.

Kotliar, N.B., Baker, B.W., Whicker, A. D. and G. Plumb. 1999. A critical review of assumptions about the prairie dog as a keystone species. *Environmental Management* 24(2): 177-192.

Lai, C.H. and A. T. Smith. 2003. Keystone status of plateau pikas (*Ochotona curzoniae*): effect of control on biodiversity of native birds. *Biodiversity and Conservation* 12: 1901-1912.

Lenihan, C. M. 2007. *The ecological role of the California ground squirrel*. Ecology Graduate Group dissertation, University of California, Davis.

Ordeñana, M. A., Crooks, K. R., Boydston, E. E., Fisher, R. N., Lyren, L. M., Siudyla, S., Haas, C. D., Harris, S., Hathaway, S. A., Turschak, G. M., Miles, A. K. and D. H. Van Vuren. 2010. Effects of urbanization on carnivore species distribution and richness. *Journal of Mammalogy* 91:1322–1331.

Owings, D. H. 2002. The cognitive defender: how ground squirrels assess their predators. p. 19-25 in M. Bekoff, C. Allen, and G. Burghardt. Eds. *The cognitive animal.* MIT Press, Cambridge.

Owings, D. H. and D. F. Hennessey. 1984. The importance of variation in sciurid visual and vocal communication. Pages 169-200 in J. A. Murie and G. R. Michener, eds. *The biology of ground-dwelling squirrels: Annual cycles, behavioural ecology, and sociality*. University of Nebraska Press, Lincoln.

Paine R.T. 1969. A note on trophic complexity and community stability. *American Naturalist* 103:91-93.

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

Reilly, M., Tobler, M.W., Sonderegger, D. L. and P. Beier. 2017. Spatial and temporal response of wildlife to recreational activities in the San Francisco Bay ecoregion. *Biological Conservation* 207:117–126.

Severson, K. E. and G. E. Plumb. 1998. Comparison of methods to estimate population densities of black-tailed prairie dogs. *Wildlife Society Bulletin* 26: 859-866.

Smith A.T. and J. M. Foggin. 1999. The plateau pika (*Ochotona curzoniae*) is a keystone species for biodiversity on the Tibetan plateau. *Animal Conservation* 2: 235-240.

Thomas L., Laake, J.L., Strindberg, S., Marques, F.F.C., Buckland, S.T., Borchers, D.L., Anderson, D.R., Burnham, K.P., Hedley, S.L., Pollard, J.H., Bishop, J.R.B. and T. A. Marques. 2005. *Distance 5.0. Release 1*. Research Unit for Wildlife Population Assessment, University of St. Andrews, UK. http://www.ruwpa.st-and.ac.uk/distance/

Townsend S.E. 2005. Burrow cluster as a sampling unit: An approach to estimate marmot activity in the Eastern Steppe in Mongolia*. Mongolian Journal of Biological Sciences*.

Wang, Y., M. L. Allen and C. C. Wilmers. 2015. Mesopredator spatial and temporal responses to large predators and human development in the Santa Cruz Mountains of California. *Biological Conservation* 190:23–33.

Wilmers, C.C., Wang, Y., Nickel, B., Houghtaling, P., Shakeri, Y., Allen, M.L., Kernish-Wells, J. Tovovish, V. and T. Williams. 2013. Scale dependent behavioral responses to human development by a large predator, the puma. *PLos One* 8(4):e60590. doi:10.1371/journal.pone.0060590.

Whittington, J., C. Cassady St. Clair and G. Mercer. 2005. Spatial responses of wolves to roads and trails in mountain valleys. *Ecological Applications* 15:543–553.

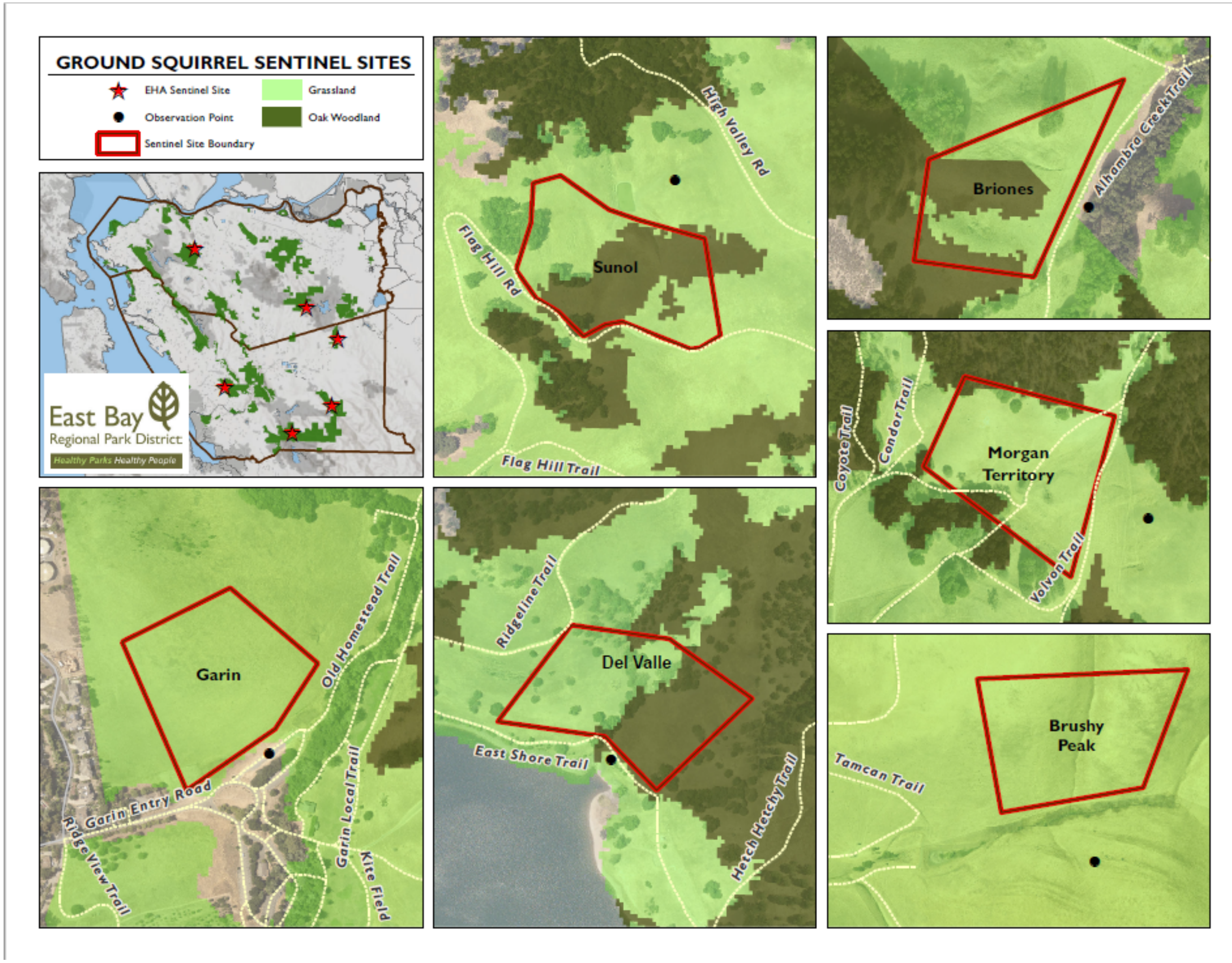
Wright J.P. and Jones C.G. 2006. The concept of organisms as ecosystem engineers ten years on: progress, limitations, and challenges. *BioScience* 56:203-209.

Table 4: Burrow density estimate (D) and burrow cluster density estimate (DS) for the California ground squirrel sentinel sites in the subregions int eh EHA Area of Focus, Alameda and Contra Costa counties, California

Subregions	Park		Estimate	%CV	df	LCL	UCL
Area of Focus							
Mount Diablo	Brushy Peak	D	6,852	37.02	1.62	985	47,662
Mount Diablo	Morgan Territory	D	10,590	21.71	44.69	6,873	16,317
Mount Hamilton	Sunol	D	30,082	31.41	100.83	16,370	55,281
Mount Hamilton	Del Valle	D	30,357	19.39	43.09	20,605	44,723
East Bay Hills	Garin	D	35,772	37.17	6.04	14,857	86,135
East Bay Hills	Briones	D	36,350	38.46	83.63	17,367	76,083

Mount Diablo	Brushy Peak	DS	3,405	34.28	1.20	187	62,167
Mount Diablo	Morgan Territory	DS	3,730	8.60	16.67	3,111	4,472
Mount Hamilton	Sunol	DS	6,329	24.02	52.85	3,936	10,177
Mount Hamilton	Del Valle	DS	8,811	11.34	7.16	6,752	11,498
East Bay Hills	Garin	DS	9,230	32.92	3.74	3,695	23,058
East Bay Hills	Briones	DS	7,420	31.39	46.04	4,004	13,751

Figure 1: Ground squirrel sentinel sites



APPENDIX I. BAT ROOSTING SURVEY MONITORING PROTOCOL

Wisconsin Summer Bat Colony Monitoring

WISCONSIN
BAT PROGRAM

http://wiatri.net/inventory/bats

Wisconsin Bat-Roost Monitoring Project

Bureau of Natural Heritage Conservation

Species Management

Wisconsin Department of Natural Resources

101 S. Webster St. PO Box 7921

Heather.kaarakka@wisconsin.gov

WISCONSIN
DEPT. OF NATURAL RESOURCES

What is summer bat colony monitoring and why is it important?

Bats are some of the most ecologically diverse animals on the planet. Over 1,300 species of bat exist worldwide and they are found on every continent except Antarctica. 45 species of bat call North America home, and eat a wide variety of foods including insects, pollen, and fruit. Because of their feeding habits, bats are an important form of pest control and also pollinate and spread many important foods we eat everyday.

In 2006, a fungus was discovered growing on the noses and wings of bats as they hibernate. The disease, later named white-nose syndrome (WNS) because of the white, powdery fungus on the muzzle of infected bats, causes die offs of multiple species of bats in infected hibernation sites, and mortality rates of 90-100% are not uncommon. In reaction to the occurrence and spread of WNS, a continent-wide response was launched in 2009 which included learning more about the disease and how to stop it, as well as what to expect should populations recover post-infection.

A little brown bat infected with WNS.

Summer roosts are critical to the survival of bats because they offer safe places to raise young and rest during the day. Bats in Wisconsin generally give birth to one baby, called a pup, in early June, making these havens important habitat for the survival and propagation of bats.

Documentation and monitoring of summer roosts is a critical part of the National Response to WNS. The true impacts of the disease cannot be determined using estimates from hibernacula alone; therefore, we are soliciting help from within and beyond the WNS affected areas to assist in a nation-wide effort to collect data during summer months through maternity colony monitoring and acoustic sampling. The rapid advance of WNS has eliminated the opportunity to collect baseline data in the affected northeastern states, but we still have time to establish some pre-WNS information in Midwestern states. Summer bat monitoring through the surveys described in this package will provide three levels of information; 1) impact of WNS on affected bat populations; 2) baseline data on populations in advance of WNS, and; 3) insight into summer symptoms and possible transmission of WNS in summer roosts. Your participation in any or all of these efforts is encouraged and will support the regional and national WNS Investigation and Response effort.

*The WNS Summer Colony Packet was designed by the PA Game Commission and has been adapted to fit the needs of the Wisconsin DNR/ Natural Heritage Conservation/Species Management section.

What's in this packet?

The information and datasheets in this packet are resources for you to use to get started with summer bat colony monitoring.

1. Summer Maternity Monitoring Q&As
2. Emergence Count Monitoring Introduction and Protocol
3. Site Surveyor Data Form
4. Site and Landowner Data Form
5. Emergence Count Data Form

Who can participate?

- Anyone interested in bat monitoring in the state can participate in summer colony monitoring. Emergence counts (colony monitoring) may be conducted by landowners, volunteers, students, researchers or staff. As most bat colonies in the summer on private lands, we are relying almost exclusively on landowners and volunteers to report colonies and conduct emergence surveys.

What does monitoring entail?

- Emergence counts: Ideally site visits are conducted at least twice a season during both the pre-volant (before flight of pups) and post-volant (after flight) time periods. Female bats give birth to pups from June 1 –July 1 which is known as the pre-volant period. As the pups mature, they are ready to forage and fly at 3-4 weeks after birth. This stage when the young begin to fly is known as the post-volant period. Emergence counts are simple and include **sitting outside the roost in the evening and counting the bats as they emerge**.

How do I get started?

- If you know of a summer bat roost, you can report the colony to the Wisconsin Bat Program by filling out the attached **surveyor** and **site datasheets** and sending them to heather.kaarakka@wisconsin.gov or mailing to:

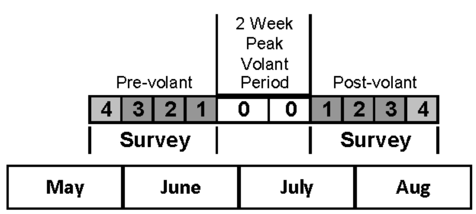
Wisconsin Department of Natural Resources

Heather Kaarakka
Bureau of Natural Heritage Conservation

101 South Webster Street

Madison, WI 53707-7921

- After your site and contact information is submitted you are free to begin emergence surveys! Use the **emergence count datasheet** to fill out survey information and email or submit your counts online on the roost project webpage.
- Commitment: There are three levels of commitment for the project.
  1. Conduct one emergence count from May through August.
  2. Conduct two emergence surveys—1 during pre-volancy and 1 during post-volancy.
  3. Conduct at least one emergence count every two weeks starting in late May through late August. Or conduct consecutive counts for at least three days during late May and early June.



A short video explaining the roost monitoring process is also available on the roost project webpage: http://wiatri.net/inventory/bats/volunteer/roost

How can I identify the species using my roost?

- In Wisconsin, the two species most likely to use bat houses, buildings and bridges are little brown bats and big brown bats. Big brown bats are about twice the size of little brown bats and the muzzle is much blacker and wider on the big brown bat. A photo of the bats in the roost submitted to the Bat Program is an easy way to definitively identify the species. Another way is to look at the guano below the roost. A submitted photo of the guano compared to a coin is helpful in determining species.


Left- big brown bat guano compared to a quarter. Right- little brown bat guano compared to a nickel.

*** Please limit disturbance of the bats while trying to identify the species. Too much disturbance can cause the bats to abandon the roost.**

Conducting emergence surveys

The Survey- It is best to do some scouting before hand to determine where bats are exiting.

- To determine the primary exit, look for discolored areas in and around chimneys, eaves, and soffits along with concentrations of guano beneath the exit. You may find that you need help in covering all the exits (front and back of a structure).
- Please try to survey when starting temperatures are above 60ºF and wind and sky codes are 3 or less. Bring a thermometer, paper and pencil, and the emergence form.
- Arrive about 15 minutes before sunset.
- Locate where the bats are exiting the structure and count them as they exit. Some may re-enter, especially when there are pups inside. Try to keep track of this. If you find that you have a mega-colony that numbers in the thousands, you may need to tally them by the 10's as they exit. ***Do not shine lights into the roost to count the bats.** Too much disturbance from lights and activity can cause the bats to abandon the roost. You will also not be able to see all the bats inside the bat house making for an incomplete count.
- There are free hand- tally apps available for smartphones that will make counting much easier.
- Position both yourself and helpers for easy viewing of bats exiting. It is best to be in position to have the bats silhouetted against the sky for easier viewing. When more than one surveyor is needed, it's a good idea to turn the count into an evening social, with dinner or an ice cream parlor visit afterwards.
- Please remember to ask permission of the landowner and enjoy the experience.

Return Survey Data to: Heather Kaarakka (Wisconsin DNR) heather.kaarakka@Wisconsin.gov or 608-266-2576 or John Paul White (WDNR) john.white@wisconsin.gov 608-267-0813.

Summer Maternity Roost Monitoring-SURVEYOR INFORMATION Data Form

White Nose Syndrome (WNS):

Multi-state Coordination, Investigation and Response to an Emerging Wildlife Health Threat

SURVEYOR INFORMATION (CONFIDENTIAL):

NAME: ____

ADDRESS: ____

____

CITY: ______________________________ STATE: ________ ZIP: ____________

PHONE: ______________________________

EMAIL: ______________________________

SURVEYOR TYPE (circle what best describes you):

Landowner -You are surveying a roost on your own property (use this even if also surveying other sites you do not own).

Volunteer -You are surveying as a volunteer and have limited expertise in both bat identification and ecology.

Student -You are a student studying bats with a basic expertise in both bat identification and ecology.

Researcher -You are actively involved in bat research on an academic and/or professional level.

COMMENTS: (Bat experience etc.)

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Summer Maternity Roost Monitoring-<u>SITE and LANDOWNER</u> Data Form

White Nose Syndrome (WNS):

Multi-state Coordination, Investigation and Response to an Emerging Wildlife Health Threat

Site name or Number: ______________________________ **2 Digit State abrev.:_________** **County**:_____________________

LAT (Decimal degrees; ex: 43.5738):_______________ (N) **LON (Decimal degrees; ex: 89.60225)**: _______________ (W)

Lat/Lon Precision (circle): GPS – From Map – County Resolution – Google Maps- Not Mapped – Other (specify) __________________________

(Circle- "GPS" if GPS unit used; "From Map" if plotted from map; "County Resolution" if coordinates are only County specific)

Roost Structure is: barn – church – occupied house – unoccupied house – utility building – bat box – bat condo – bridge – tree – cave – mine – unknown – other structure (describe):____-_

Primary Species within Roost: ______________________________or Unknown (circle if unknown)
(list only 1 if known., and make comments on others)

COMMENTS (include directions to site, where bats are exiting, how many surveyors needed at site, other species roosting, landowner's plans for the bat colony, history of site regarding bats, etc… attach more sheets if needed):

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LANDOWNER INFORMATION (CONFIDENTIAL):

NAME: ____

ADDRESS: ____

____

CITY: ____ STATE: ___________ ZIP: _________________

PHONE: ____

EMAIL: ____

RESPONSIBLE SURVEYOR NAME: ____

Summer Maternity Roost Monitoring-EMERGENCE COUNT Data Form

White Nose Syndrome (WNS)

Counts can also be submitted online! http://wiatri.net/inventory/bats/volunteer/roosts

SITE NAME or No.:---____________________________________**SURVEYOR:**___________________________

(a site/landowner data form needs completed)

(Lead Surveyor who is responsible for reporting and has completed a SURVEYOR Info data form)

Date	Sky Code	Wind Code	Start Temp	Start Time	End Time	Total Bats Counted	Technique Used (Visual or Video)

Other Surveyors

Comments:

SITE NAME or No.:---________________________________ **SURVEYOR:** ___________________________

(a site/landowner data form needs competed at least once)

(Lead Surveyor who is responsible for reporting and has completed a SURVEYOR Info data form)

Date	Sky Code	Wind Code	Start Temp	Start Time	End Time	Total Bats Counted	Technique Used (Visual or Video)

Other Surveyors

Comments:

			WIND	
1	Clear-Clear to a few clouds	1	Calm-Leaves Still	0 MPH
2	Partly Cloudy-Clouds but variable sky conditions	2	Slight Breeze-Leaves slightly Rustling	1-7 MPHD-FASD 1-7 MPH
3	Cloudy-Mostly cloudy or overcast	3	Gentle Breeze-Leaves and twigs in motion	8-12 MPH
4	Drizzle-Light intermittent rain	4	Mod. Breeze-Small branches begin to move	13-18 MPH
5	Showers-Steady soaking rain	5	Windy-Small Trees or more in canopy sway	19-24+ MPH
6	Thunderstorms-Rain with thunderstorms	6	Not Recorded-	Not Recorded
7	Not Recorded-Not Recorded			

Sky and wind codes of 1 – 3 are best. Code of 4 is marginal. Avoid surveying if code is higher than 4.

Summer Maternity Roost Monitoring-Reporting Sick/Dead Bats Data Form

White Nose Syndrome (WNS):

Multi-state Coordination, Investigation and Response to an Emerging Wildlife Health Threat

Please fill out an on-line Sick/Dead bats form here: http://wiatri.net/inventory/bats/Reporting/
or you can complete the form below and send it to:

Wisconsin DNR
Natural Heritage Conservation
Paul White
101 S. Webster St.
Madison, WI 53707-7921

* Indicates Required Fields

* Name: ____

Address1: ____

Address2: ____

* City: ____

*State: _____ Zip Code: _____________

* Phone #: ________________________

* E-mail: _________________________

* Number of Bats Found: ____________

* Date of Observation: (mm/dd/yyyy) ______________________

* County of Observation ______________________________

* Description of Location:

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____
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Additional Comments:

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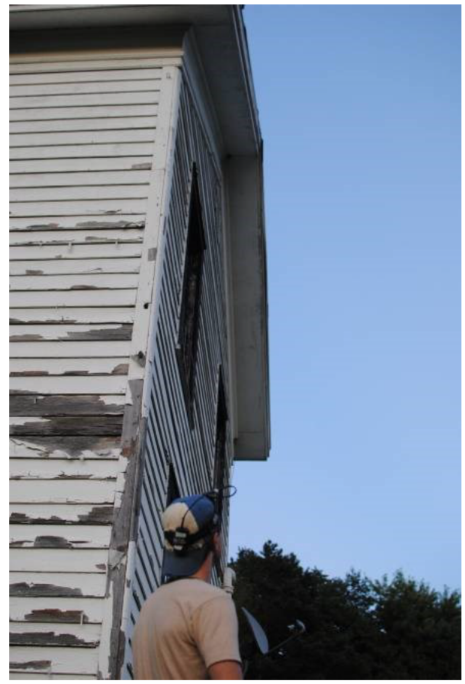
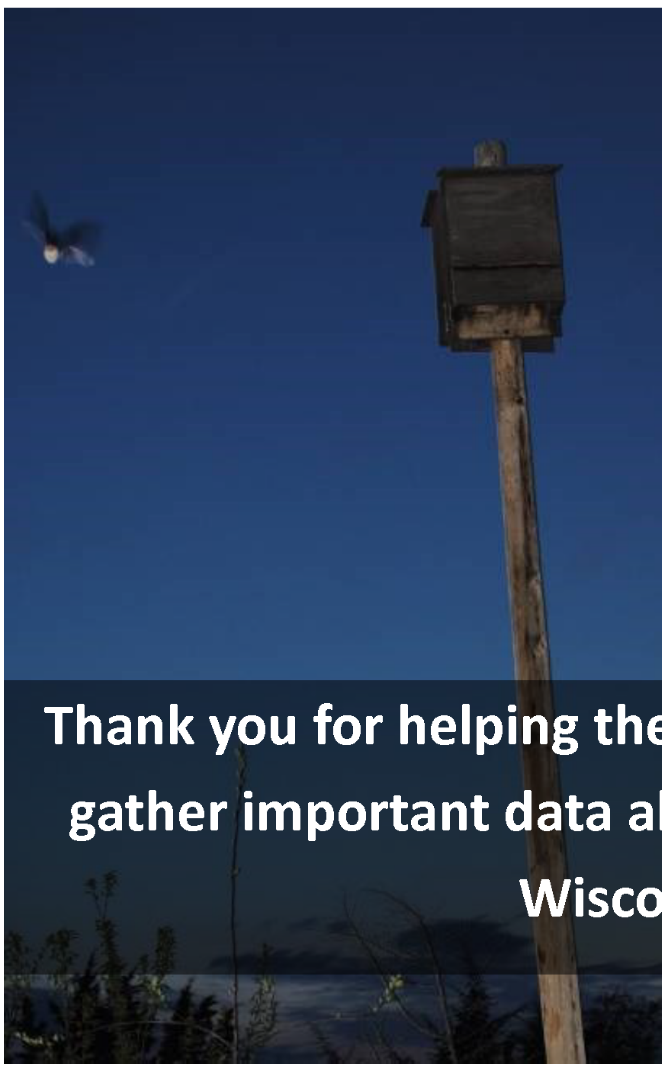
A few bat counting tips

- Sit or stand so that you can see the bats fly out of the roost against the night sky. It is much easier to see them with a light backdrop. If at a building, sit so that you are looking along the side of the wall, not straight on.
- Bats will begin exiting 15-20 minutes after sunset and will continue to exit for about 30-40 minutes. In all, the count should not take more than an hour to complete.
- Not all bats will exit during the survey. A few will remain in the roost. To tell when you can stop counting, wait for a five minute period, and if no bats have exited, or if it is too dark to see, you have completed your survey. Remaining bats will sometimes make noise indicating that some still remain in the roost.



Researcher looking along the wall for bats emerging against the night sky.



Citizen-scientists and volunteers are critical to monitoring Wisconsin's bats. The roost monitoring project cannot continue without your support.

Please always feel free to contact Heather with questions or concerns about bats and bat roost monitoring. Heather.kaarakka@wisconsin.gov or 608.266.2576

Thank you for helping the Wisconsin Bat Program gather important data about bat populations in Wisconsin.