



**CPS 2009 RFP
FINAL PROJECT REPORT**

Project Title

Wildlife Survey for *E. coli* O157:H7 and *Salmonella* in the Central Coastal Counties of California

Project Period

October 1, 2009 – November 30, 2011

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Objective

We collected samples from nine geographical regions (i.e., watershed) within three California central coastal counties to develop conclusive results regarding which species of wildlife are a significant or insignificant risk to produce safety. We collected fecal samples to determine if wild animals are carrying human pathogenic strains *Escherichia coli* O157:H7 and *Salmonella*. This information will help the produce industry better manage and protect wildlife and provide food health safety information to farmers and to the food industry, and for agencies to develop policy and wildlife management plans to reduce the food safety wildlife uncertainty. The future of

sustainable wildlife populations is dependent on having cumulative and accurate scientific data to properly manage wildlife and to protect human health. The purpose is to bring practical science and farm practice to the farming and ranching communities.

Project tasks: 1: network with landowners; 2: Trapping and netting; 3: hunter check stations; 4: trap geese; 5: lab analysis

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Abstract

We tested 924 small rodents, 873 small birds, 469 Canada geese (*Branta canadensis*) (including 47 recaptures), 444 coastal black-tailed deer (*Odocoileus hemionus columbianus*), 240 wild pigs (*Sus scrofa*) and 149 Tule elk (*Cervus canadensis nannodes*) for *Escherichia coli* O157:H7 from Monterey, San Benito, and San Luis Obispo Counties (Figure 1). All the small rodents, birds, geese, and deer were negative for *E. coli* O157:H7, except one Dark-eyed (Oregon) Junco was positive for *E. coli* O157:H7. Three (2.0%) elk and 10 (4.2%) pigs were positive for *E. coli* O157:H7.

We tested 562 rodents, 514 birds, 220 geese, 175 deer, 102 wild pigs and 76 elk for *Salmonella*. Twenty (7.4%) rodents, 14 (2.7%) birds, four (2.3%) deer, three (3.9%) elk and six (5.9%) wild pigs were positive for *Salmonella*. Eleven of the positive rodents were from the California ground squirrel (*Spermophilus beecheyi*) ($n = 59$), five were from the deer mouse (*Peromyscus maniculatus*) ($n = 277$), three from the house mouse (*Mus musculus*) ($n = 16$) and one was from the black rat (*Rattus rattus*) ($n = 15$). All of the positive ground squirrels were from one location. All the geese were negative for *Salmonella*.

Background

Research Methods

We conducted a survey of wildlife across California's three central coastal counties that support leafy-green production from 36 sites on both private and public properties (Figure 1). We collected fecal samples using anal swabs from small birds, Canada geese, and small mammals, and colons from wild pigs, elk, and deer. Small birds were captured using mist nets or Potter traps and small mammals were captured using live-box traps. Canada geese were captured during their flightless molt season using funnel traps. Big game colons were collected from freshly hunter-killed deer, elk, and wild pigs or as a result of depredation permits.

Fecal samples were collected from birds and rodents using anal swabs and placed into transport media tubes and colons were placed in zip-locked plastic bags. All samples were shipped one-day service to the laboratories with blue-ice. Fecal material was placed into Trypticase Soy Broth enrichment at 25°C for two hours with shaking at 100 rpm, then at 42°C for 8 hours at 100 rpm, and held overnight at 6°C, followed by IMS. Broth cultures were plated onto two separate selective media (TC-SMAC and Rainbow Agar) for isolation and confirmation. All samples were analyzed by USDA-ARS or UC Davis WIFSS laboratories.

Results

We captured 17 species of rodents and 63 species of small birds from a variety of habitats. The habitats included oak woodland, grasslands, riparian zones, and agricultural production fields. All geese, rodents and deer were negative for *E. coli*

O157:H7 (Tables 1, 2, and 3). Only one (0.11%) small bird, an Dark-eyed (Oregon) Junco), three (2.0%) Tule elk ($n = 149$) and 10 (4.2%) wild pigs ($n = 240$) were positive for *E. coli* O157:H7. The junco was captured in native habitat approximately 20 kilometers from 2006 spinach outbreak and the strain isolated was similar to the 2006 outbreak.

All the Canada geese were negative for *Salmonella*. Twenty rodents (11 California ground squirrels, 5 deer mice, 3 house mice and one black rat) were positive for *Salmonella*. Fourteen birds (2.7%), representing eleven species, were positive for *Salmonella*. Four deer (2.3%) ($n = 175$), three elk (3.9%) ($n = 76$) and six wild pigs (5.9%) ($n = 102$) were positive for *Salmonella*. All positive deer and elk were from herds that occupy natural habitat areas and were not near agricultural production areas.

Outcomes and Accomplishments

With better knowledge about the spatial and temporal incidence of *E. coli* O157:H7 and *Salmonella* in local wildlife, this data will provide more accurate information for growers, landowners, processors and auditors in order for them to make decisions that will balance food safety concerns with wildlife management. The results will assist resource agencies and growers in developing strategies, management plans and policies for preventing crop contamination in the fields to protect public health and to protect wildlife and their habitats.

Farmers are being pressured, at great economic expense, to build deer- and wild pig-proof fences around their fields, and remove habitat and wildlife from their farms.

We found that the occurrence of *E. coli* O157:H7 is negative in almost all **native** wildlife, including deer, and rare in birds and elk, indicating that the risk of food contamination with O157:H7 is low from these species. The single positive small bird (junco) had the same strain that was isolated during the 2006 spinach outbreak suggesting this strain continues to exist in the environment. However, it remains unknown where or how this individual bird came in contact with this strain. The highest prevalence of *E. coli* O157:H7 and *Salmonella* was in the non-native wild pig, which may indicate that the risk from these species is higher. *Salmonella* was detected in a larger diversity of avian and mammalian species and may indicate that under certain high density situations (i.e. flocks of birds, colony of California ground squirrels) the food safety risk is more elevated if these species are in close proximity to produce fields. Please note, these results show that some wild animals carry *Salmonella*, but the level of significance remains unknown. The house mouse, black rat, and wild pig are non-native species to North America, thus, their removal will not impact native species.

Summary of Findings and Recommendations

The prevalence of *E. coli* O157:H7 and *Salmonella* appears to be low in native wildlife and is highest in non-native wild pig. Comparing this study to other California food safety-wildlife studies, the overall prevalence for *E. coli* O157:H7 and *Salmonella* tends to be less than 2% and around 5%, respectively, in native wildlife.

An *E. coli* O157:H7 outbreak occurred in strawberries in northern Oregon during the summer 2011. Deer have been implicated as a source for this outbreak. Farmers in the Yuma Valley, Arizona, are also concerned about deer as a potential risk to food safety. We recommend big game continue to be surveyed across the state for human pathogenic bacteria. Other studies indicate blackbirds that occupy Confined Animal Facilities, such as stock yards have a slightly higher *E. coli* O157:H7 prevalence than this study. High density flocks utilize these facilities and move out to agricultural areas to feed, thus being a potential vector to crops. As such we recommend blackbirds be surveyed for human pathogens in and nearby Confined Animal Facilities. Geese also form large concentrations on agricultural fields and roost on sewage treatment ponds, thus geese should continue to be surveyed. We tested only for two major pathogenic types of bacteria, thus we recommend other pathogenic strains associated with outbreaks or recalls of fresh produce (e.g. non-O157 Shiga toxin producing *E. coli*, *Listeria monocytogenes*) be included in future wildlife studies. Thus, we recommend funding big game, bird species that form large density flocks around agricultural facilities, and goose studies be continued.

APPENDICES

Publications and Presentations (required)

Gordus, Andrew, Robert Mandrell, and E. Robert Atwill. 2011. Wildlife Survey for *E. coli* O157:H7 and *Salmonella* in the Central Coastal Counties of California. Center for Produce Safety Annual Conference. Poster Session. Orlando, Florida.

Gorski L, Parker CT, Liang A, Cooley MB, Jay-Russell MT, Gordus AG, Atwill ER, and Mandrell RE. 2011. Prevalence, distribution and diversity of *Salmonella enterica* in a major produce region of California. *Appl Environ Microbiol* 77:2734-2748.<http://www.ncbi.nlm.nih.gov/pubmed/21378057>

Mandrell RE. Presented Division Lecture for Food Microbiology Division (P) of the American Society for Microbiology at the 111th General Meeting, New Orleans, LA; "Microbial food safety of produce: In the lab and in the field." May 22, 2011.

Budget Summary (required)

As of 12/21/2011 DFG has invoiced:

Salaries	Benefits	Supplies	Travel	Total
\$ 32,938.91	\$ 2,643.53	\$ 2,404.56	\$ 13,725.77	\$ 51,712.77

As of 12/21/2011 ARS has invoiced:

\$43,468.50	\$14,489.50	\$29,107	0	\$87,065
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As of 12/21/2011 WIFSS has spent:

\$45,015.35	\$19,128.79	\$24,954.82	0	\$89,098.96
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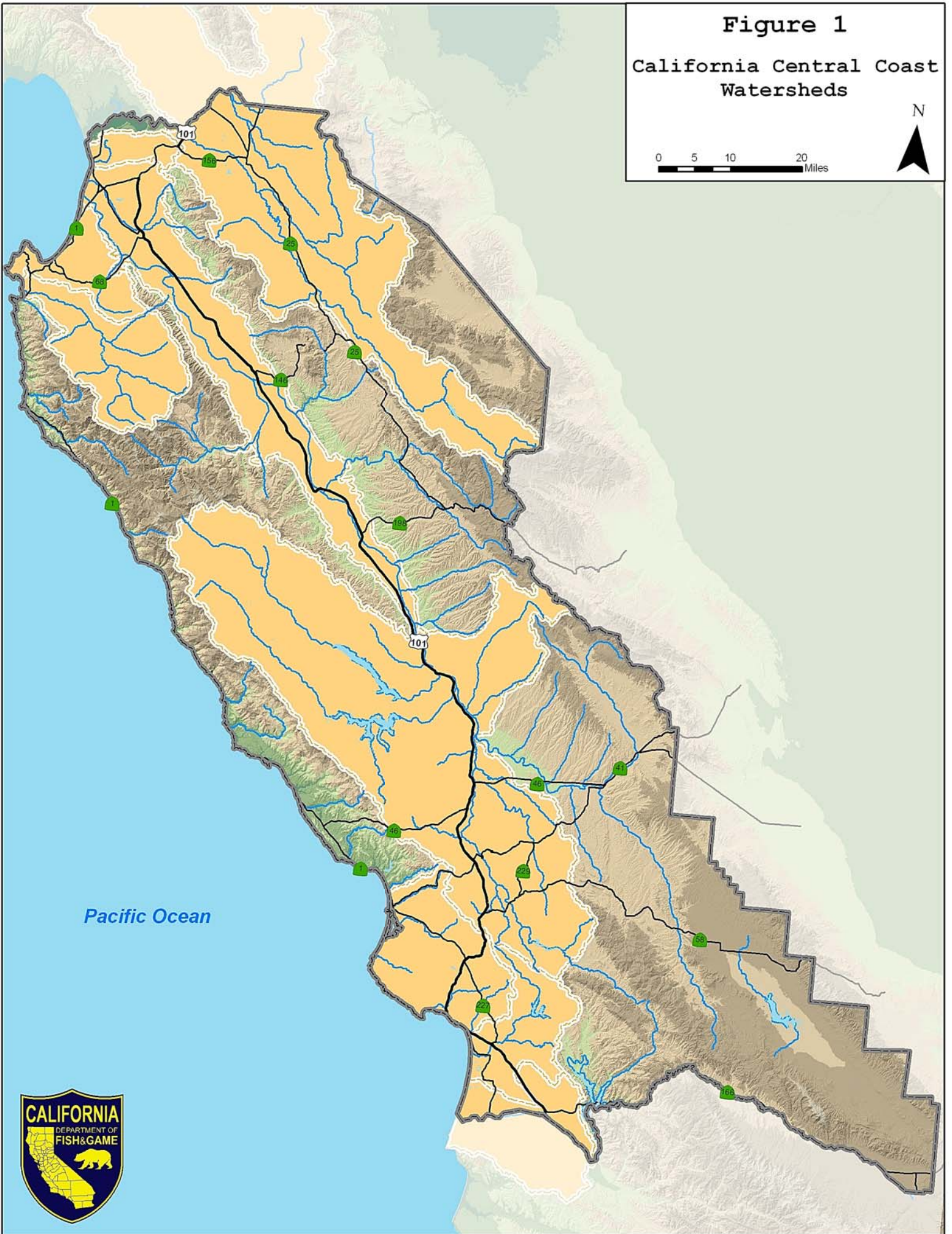
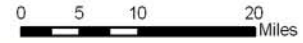
Tables and Figures (optional)

Figure 1.

Tables 1, 2, 3.

Figure 1

California Central Coast Watersheds



Pacific Ocean



Table 1. Prevalence of *E. coli* O157:H7 and *Salmonella* from birds sampled from the central coastal counties of California.

Common Name	Species	Resident	Migrant	Total			
				<i>E. coli</i> O157:H7		<i>Salmonella</i> sp.	
				+	n	+	n
Canada Goose*	<i>Branta canadensis</i>	x			469		220
Killdeer	<i>Charadrius vociferus</i>	x			1		1
Sharp-Shinned Hawk	<i>Accipiter striatus</i>	x			1		1
California Quail	<i>Callipepla californica</i>	x			19		14
Mourning Dove	<i>Zenaidura macroura</i>	x			7		6
Acorn Woodpecker	<i>Melanerpes formicivorus</i>	x			1		0
Nuttall's Woodpecker	<i>Picoides nuttallii</i>	x			8	1	3
Northern Flicker	<i>Colaptes auratus</i>	x			3		2
Greater Peewee	<i>Contopus pertinax</i>		x		1		1
Least Flycatcher	<i>Empidonax minimus</i>		x		1		0
Dusky Flycatcher**	<i>Empidonax oberholseri</i>		x		2		0
Pacific-Slope Flycatcher***	<i>Empidonax difficilis</i>		x		13		5
Black Phoebe	<i>Sayornis nigricans</i>	x			10		8
Ash Throated Flycatcher***	<i>Myiarchus cinerascens</i>		x		3	1	3
Western Kingbird	<i>Tyrannus verticalis</i>		x		1		1
Loggerhead Shrike	<i>Lanius ludovicianus</i>	x			6	1	6
Steller's Jay	<i>Cyanocitta stelleri</i>	x			1		1
Western Scrub-Jay	<i>Aphelocoma californica</i>	x			16	2	7
Western Bluebird	<i>Sialia mexicana</i>	x			5		5
Swainson's Thrush***	<i>Catharus ustulatus</i>		x		1		0
Hermit Thrush	<i>Catharus guttatus</i>	x			13		5
Tree Swallow	<i>Tachycineta bicolor</i>	x			4		1
Violet-Green Swallow***	<i>Tachycineta thalassina</i>		x		6		6
Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>		x		1		1
Barn Swallow***	<i>Hirundo rustica</i>		x		3		2
Cliff Swallow***	<i>Petrochelidon pyrrhonota</i>		x		32		30
Chestnut-Backed Chickadee	<i>Parus rufescens</i>	x			17		0
Oak Titmouse	<i>Baeolophus inornatus</i>	x			26		7
Bushtit	<i>Psaltriparus minimus</i>	x			8	1	6
White-Breasted Nuthatch	<i>Sitta carolinensis</i>	x			6		5
Bewick's Wren	<i>Thryomanes bewickii</i>	x			13		6
House Wren	<i>Troglodytes aedon</i>	x			7		0
Ruby-Crowned Kinglet	<i>Regulus calendula</i>		x		8		4
Wrentit	<i>Chamaea fasciata</i>	x			12		4
Northern Mockingbird	<i>Mimus polyglottos</i>				5		5
California Thrasher	<i>Toxostoma redivivum</i>	x			6		2
European Starling	<i>Sturnus vulgaris</i>	x			21		17
Orange-Crowned Warbler	<i>Oreothlypis celata</i>	x			6		4
Nashville Warbler	<i>Vermivora ruficapilla</i>		x		1		1
Yellow Warbler	<i>Dendroica petechia</i>		x		2		2
Yellow-Rumped Warbler***	<i>Dendroica coronata</i>		x		14		9
Common Yellowthroat	<i>Geothlypis trichas</i>	x			4		2
Wilson's Warbler	<i>Wilsonia pusilla</i>		x		2		2
Spotted Towhee	<i>Pipilo maculatus</i>	x			31	1	9
California Towhee	<i>Pipilo crissalis</i>	x			45	1	31
Chipping Sparrow	<i>Spizella passerina</i>		x		1		1
Savannah Sparrow	<i>Passerculus sandwichensis</i>	x			1		1
Grasshopper Sparrow***	<i>Ammodramus savannarum</i>		x		9		3
Fox Sparrow	<i>Passerella iliaca</i>		x		4		1
Song Sparrow	<i>Melospiza melodia</i>	x			90	2	44
Lincoln's Sparrow	<i>Melospiza lincolni</i>		x		6		6
White-Crowned Sparrow	<i>Zonotrichia leucophrys</i>		x		128	2	100
Golden-Crowned Sparrow	<i>Zonotrichia atricapilla</i>		x		56		30
Dark-Eyed (Oregon) Junco	<i>Junco hyemalis</i>	x			54	1	12
Black-Headed Grosbeak***	<i>Pheucticus melanocephalus</i>		x		1		1
Red-Winged Blackbird	<i>Agelaius phoeniceus</i>	x			50		40
Western Meadowlark	<i>Sturnella neglecta</i>	x			1		1
Brewer's Blackbird	<i>Euphagus cyanocephalus</i>	x			9		3
Bullock's Oriole***	<i>Icterus bullockii</i>		x		11		9
Purple Finch	<i>Carpodacus purpureus</i>	x			6		1
House Finch	<i>Carpodacus mexicanus</i>	x			37	1	24
Lesser Goldfinch	<i>Spinus psaltria</i>	x			12	1	10
Lawrence's Goldfinch	<i>Spinus lawrencei</i>	x			2		0
American Goldfinch	<i>Spinus tristis</i>	x			2		2
Total Small Birds				1 (0.11%)	873	14 (2.7%)	514

*Includes 47 recaptures in 2010 that were captured in 2009.

**Rare breeder.

*** Summer resident and local breeder.

****Local summer breeder, common migrant and winter visitor.

Table 2. Prevalence of *E. coli* O157:H7 and *Salmonella* from small mammals sampled from the central coastal counties of California.

Common Name	Species	<i>E. coli</i> O157:H7		<i>Salmonella</i> sp.	
		+	<i>n</i>	+	<i>n</i>
Merriam's Chipmunk	<i>Tamias merriami</i>		4		0
California Pocket Mouse	<i>Chaetodipus californicus</i>		27		12
Heerman's Kangaroo Rat	<i>Dipodomys heermanni</i>		22		2
Narrow-faced Kangaroo Rat	<i>Dipodomys venustus</i>		1		1
California Mouse	<i>Peromyscus californicus</i>		64		22
Deer Mouse	<i>Peromyscus maniculatus</i>		406	5	277
Brush Mouse	<i>Peromyscus boylii</i>		24		10
Piñon Mouse	<i>Peromyscus truei</i>		106		51
Harvest Mouse	<i>Reithrodontomys megalotis</i>		30		25
Dusky-Footed Woodrat	<i>Neotoma fuscipes</i>		66		6
Desert Woodrat	<i>Neotoma lepida</i>		4		4
Big-eared woodrat	<i>Neotoma macrotis</i>		13		7
Meadow Vole	<i>Microtus californicus</i>		63		54
House Mouse	<i>Mus musculus</i>		17	3	16
Black Rat	<i>Rattus rattus</i>		17	1	15
Trowbridge's Shrew	<i>Sorex trowbridgii</i>		1		1
California Ground Squirrel	<i>Spermophilus beechyi</i>		59	11	59
Total		0	924	20 (3.6%)	562

Table 3. Big game results for *E. coli* O157:H7 and *Salmonella*.

Species	<i>E. coli</i> O157:H7		<i>Salmonella</i> sp.	
	+	<i>n</i>	+	<i>n</i>
Coastal Black-tailed Deer (<i>Odocoileus hemionus columbianus</i>)	0	444	4 (2.3%)	175
Tule Elk (<i>Cervus canadensis nannodes</i>)	3 (2.0%)	149	3 (3.9%)	76
Wild Pig (<i>Sus scrofa</i>)	10 (4.2%)	240	6 (5.9%)	102
Total	13 (1.6%)	833	13 (3.7%)	353

Acknowledgements:

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Suggestions to CPS (optional)

Fund big game, bird species that form large density flocks around agricultural facilities, and goose studies.