

# You Want Flies with That?

Farm Biodiversity and Food Safety

Health from the Soil Up

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Figure: FAO: Cattle under Coconut, Sri Lanka

# Comanaging fresh produce for nature conservation and food safety

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In 2006, a deadly *Escherichia coli* O157:H7 outbreak in bagged spinach was traced to California's Central Coast region, where >70% of the salad vegetables sold in the United States are produced. Although no definitive cause for the outbreak could be determined, wildlife was implicated as a disease vector. Growers were subsequently pressured to minimize the intrusion of wildlife onto their farm fields by removing surrounding noncrop vegetation. How vegetation removal actually affects foodborne pathogens remains unknown, however. We combined a fine-scale land use map with three datasets comprising ~250,000 enterohemorrhagic *E. coli* (EHEC), generic *E. coli*, and *Salmonella* tests in produce, irrigation water, and rodents to quantify whether seminatural vegetation surrounding farmland is associated with foodborne pathogen prevalence in California's Central Coast region. We found that EHEC in fresh produce increased by more than an order of magnitude from 2007 to 2013, despite extensive vegetation clearing at farm field margins. Furthermore, although EHEC prevalence in produce was highest on farms near areas suitable for livestock grazing, we found no evidence of increased EHEC, generic *E. coli*, or *Salmonella* near nongrazed, seminatural areas. Rather, pathogen prevalence increased the most on farms where noncrop vegetation was removed, calling into question reforms that promote vegetation removal to improve food safety. These results suggest a path forward for comanaging fresh produce farms for food safety and environmental quality, as federal food safety reforms spread across ~4.5 M acres of US farmland.

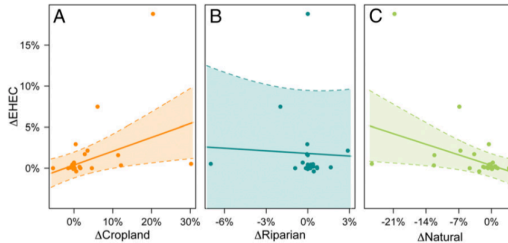
pathogens are carried by domestic animals (e.g., cattle) and wildlife; however, whereas *S. enterica* is readily isolated from many wildlife hosts (10, 11), EHEC is generally more prevalent in cattle than in wildlife. In one study, for example, 37.9% of cattle vs. only 7.4% of wildlife samples obtained from California's Central Coast tested positive for EHEC (12). Prevalence can vary by location, however; for example, ~12% of cattle shed the EHEC strain *E. coli* O157:H7 in the midwestern United States (13), whereas only 2.6–7.1% did so in California's Central Coast (12, 14). Similarly, whereas *E. coli* O157:H7 was detected in <2% of bird, deer/elk, and feral pig samples across 50 studies worldwide (15), detection rates were higher in the Central Coast region (22%, 3.4%, and 4.7%, respectively) (12). These higher rates suggest that wildlife could potentially vector *E. coli* onto farm fields (6).

If it discourages wildlife vector movements onto farm fields, then vegetation removal could mitigate food safety risk. The influence of noncrop vegetation in farming landscapes on EHEC or *Salmonella* prevalence is unknown, however. Although some pathogens are sufficiently prevalent to enable investigation of the effects of surrounding landscape composition on pathogens (16), low pathogen prevalence generally constrains such investigations. One response to this situation has been to relate landscape features to indicators (e.g., generic *E. coli*) as a proxy for known pathogens (17, 18). Another approach has been to assume that exposures result primarily from contact with local livestock or

## Significance

Fresh produce has become the primary cause of foodborne illness in the United States. A widespread concern that wildlife vector foodborne pathogens onto fresh produce fields has led to strong pressure on farmers to clear noncrop vegetation surrounding their farm fields. We combined three large data-sets to demonstrate that pathogen prevalence in fresh produce is rapidly increasing, that pathogens are more common on farms closer to land suitable for livestock grazing, and that vegetation clearing is associated with increased pathogen prevalence over time. These findings contradict widespread food safety reforms that champion vegetation clearing as a pathogen mitigation strategy. More generally, our work indicates that achieving food safety and nature conservation goals in produce-growing landscapes is possible.

Figure: Karp et al., 2015, significance



**Fig. 3.** (A) EHEC prevalence in leafy greens increased on farms that replaced nonriparian natural vegetation with crops between 2005 and 2012 (likelihood ratio test:  $n = 28$  farms,  $\chi^2 = 4.22$ ,  $P = 0.04$ ). (B and C) In contrast, EHEC did not change when riparian vegetation was removed ( $n = 28$ ,  $\chi^2 = 0.07$ ,  $P = 0.79$ ) (B) and increased when other natural vegetation was removed (note the negative scale of the x-axis;  $n = 28$ ,  $\chi^2 = 4.55$ ,  $P = 0.03$ ) (C). Solid lines depict predicted effects on EHEC from linear models, dotted lines are prediction intervals, and points are farms.

Figure: Karp et al., 2015, trends

1	What was te	Test Year	Test County	Nearest Tow	Farm	Cod Crop	Total Tests	# Positive for EHEC	# Positive for Salmonella
2	Fresh produi	2007	Monterey	San Lucas		58 Arugula	10	0	0
3	Fresh produi	2007	Monterey	King City		37 Arugula	83	0	0
4	Fresh produi	2007	Monterey	King City		39 Arugula	79	0	0
5	Fresh produi	2007	Monterey	King City		50 Arugula	8	0	0
6	Fresh produi	2007	Monterey	Soledad		62 Arugula	195	0	0
7	Fresh produi	2007	Monterey	Soledad		99 Arugula	226	0	0
8	Fresh produi	2007	Monterey	Chular		55 Arugula	21	0	0
9	Fresh produi	2007	Monterey	Chular		43 Arugula	65	0	0
10	Fresh produi	2007	Monterey	Chular		74 Arugula	29	0	0
11	Fresh produi	2007	Monterey	Chular		95 Arugula	22	0	0
12	Fresh produi	2007	Monterey	Chular		41 Arugula	17	0	0
13	Fresh produi	2007	Monterey	Chular		42 Arugula	17	0	0
14	Fresh produi	2007	Monterey	Chular		94 Arugula	19	0	0
15	Fresh produi	2007	San Benito	Hollister		31 Arugula	172	0	0
16	Fresh produi	2007	San Benito	Hollister		27 Arugula	21	0	0
17	Fresh produi	2007	Monterey	Watsonville		5 Arugula	77	0	0
18	Fresh produi	2007	San Benito	Hollister		23 Arugula	106	0	0
19	Fresh produi	2007	Monterey	Watsonville		33 Arugula	39	0	0
20	Fresh produi	2008	Monterey	San Lucas		58 Arugula	2	0	0
21	Fresh produi	2008	Monterey	King City		37 Arugula	177	0	0
22	Fresh produi	2008	Monterey	King City		39 Arugula	276	0	0
23	Fresh produi	2008	Monterey	San Lucas		63 Arugula	56	0	0
24	Fresh produi	2008	Monterey	King City		100 Arugula	19	0	0
25	Fresh produi	2008	Monterey	King City		50 Arugula	235	0	0
26	Fresh produi	2008	Monterey	King City		53 Arugula	45	0	0
27	Fresh produi	2008	Monterey	Soledad		62 Arugula	133	0	0
28	Fresh produi	2008	Monterey	Soledad		99 Arugula	164	0	0
29	Fresh produi	2008	Monterey	Chular		43 Arugula	86	0	0
30	Fresh produi	2008	Monterey	Salinas		44 Arugula	62	0	0
31	Fresh produi	2008	Monterey	Chular		95 Arugula	11	0	0
32	Fresh produi	2008	Monterey	Chular		41 Arugula	17	0	0
33	Fresh produi	2008	Monterey	Spreckels		79 Arugula	104	0	0
34	Fresh produi	2008	Monterey	Chular		42 Arugula	85	0	0
35	Fresh produi	2008	Monterey	Salinas		75 Arugula	16	0	0
36	Fresh produi	2008	San Benito	Hollister		34 Arugula	2	0	0
37	Fresh produi	2008	San Benito	Hollister		31 Arugula	2	0	0
38	Fresh produi	2008	Monterey	Watsonville		5 Arugula	46	0	0
39	Fresh produi	2008	San Benito	Hollister		25 Arugula	28	0	0
40	Fresh produi	2008	Monterey	Watsonville		26 Arugula	10	0	0
41	Fresh produi	2008	San Benito	Hollister		23 Arugula	258	0	0
42	Fresh produi	2008	Monterey	Watsonville		33 Arugula	18	0	0
43	Fresh produi	2009	Monterey	San Ardo		40 Arugula	110	0	0
44	Fresh produi	2009	Monterey	San Lucas		58 Arugula	79	0	0
45	Fresh produi	2009	Monterey	King City		37 Arugula	113	0	0
46	Fresh produi	2009	Monterey	King City		39 Arugula	75	0	0
47	Fresh produi	2009	Monterey	San Lucas		63 Arugula	451	5	0
48	Fresh produi	2009	Monterey	King City		50 Arugula	214	0	0
49	Fresh produi	2009	Monterey	King City		68 Arugula	43	0	0
50	Fresh produi	2009	Monterey	Greenfield		51 Arugula	23	0	0
51	Fresh produi	2009	Monterey	Soledad		99 Arugula	165	0	0

57	Fresh produ	2009	San Benito	Hollister	31	Arugula	44	4	0
58	Fresh produ	2009	San Benito	Hollister	25	Arugula	233	0	0
59	Fresh produ	2009	San Benito	Hollister	23	Arugula	135	0	0
60	Fresh produ	2009	Monterey	Watsonville	28	Arugula	32	0	0
61	Fresh produ	2010	Monterey	King City	39	Arugula	11	0	0
62	Fresh produ	2010	Monterey	San Lucas	63	Arugula	54	0	0
63	Fresh produ	2010	Monterey	King City	52	Arugula	2575	0	2
64	Fresh produ	2010	Monterey	Soledad	62	Arugula	3	0	0
65	Fresh produ	2010	Monterey	Gonzales	49	Arugula	10	0	0
66	Fresh produ	2010	San Benito	Hollister	30	Arugula	29	0	0
67	Fresh produ	2010	San Benito	Hollister	18	Arugula	47	0	0
68	Fresh produ	2010	Monterey	Watsonville	28	Arugula	1	0	0
69	Fresh produ	2011	Monterey	San Ardo	40	Arugula	103	0	0
70	Fresh produ	2011	Monterey	King City	37	Arugula	108	0	0
71	Fresh produ	2011	Monterey	King City	39	Arugula	29	0	0
72	Fresh produ	2011	Monterey	San Lucas	63	Arugula	107	0	0
73	Fresh produ	2011	Monterey	King City	50	Arugula	154	0	0
74	Fresh produ	2011	Monterey	King City	68	Arugula	45	0	0
75	Fresh produ	2011	Monterey	King City	52	Arugula	1	0	0
76	Fresh produ	2011	Monterey	Soledad	60	Arugula	61	0	0
77	Fresh produ	2011	Monterey	Soledad	99	Arugula	36	0	0
78	Fresh produ	2011	Monterey	Salinas	44	Arugula	6	0	0
79	Fresh produ	2011	Monterey	Chular	41	Arugula	7	0	0
80	Fresh produ	2011	San Benito	Paicines	92	Arugula	35	0	0
81	Fresh produ	2011	San Benito	Hollister	34	Arugula	202	0	0
82	Fresh produ	2011	San Benito	Hollister	29	Arugula	85	0	0
83	Fresh produ	2011	San Benito	Hollister	30	Arugula	69	0	0
84	Fresh produ	2011	San Benito	Hollister	31	Arugula	51	0	0
85	Fresh produ	2011	San Benito	Hollister	27	Arugula	192	1	0
86	Fresh produ	2011	San Benito	Hollister	25	Arugula	134	0	0
87	Fresh produ	2011	San Benito	Hollister	18	Arugula	9	0	0
88	Fresh produ	2011	Santa Cruz	Watsonville	35	Arugula	21	0	0
89	Fresh produ	2011	Monterey	Watsonville	33	Arugula	18	0	0
90	Fresh produ	2011	Monterey	Watsonville	28	Arugula	97	0	0
91	Fresh produ	2012	Monterey	King City	37	Arugula	165	1	0
92	Fresh produ	2012	Monterey	King City	38	Arugula	25	0	0
93	Fresh produ	2012	Monterey	San Lucas	63	Arugula	32	4	0
94	Fresh produ	2012	Monterey	King City	53	Arugula	67	0	0
95	Fresh produ	2012	Monterey	King City	67	Arugula	37	0	0
96	Fresh produ	2012	Monterey	Soledad	60	Arugula	81	0	0
97	Fresh produ	2012	Monterey	Soledad	99	Arugula	24	0	0
98	Fresh produ	2012	San Benito	Hollister	34	Arugula	101	0	0
99	Fresh produ	2012	San Benito	Hollister	29	Arugula	92	0	0
100	Fresh produ	2012	San Benito	Hollister	30	Arugula	27	0	0
101	Fresh produ	2012	San Benito	Hollister	19	Arugula	181	2	0
102	Fresh produ	2012	San Benito	Hollister	31	Arugula	193	1	0
103	Fresh produ	2012	San Benito	Hollister	27	Arugula	172	0	0
104	Fresh produ	2012	San Benito	Hollister	25	Arugula	456	1	0
105	Fresh produ	2012	Monterey	Watsonville	26	Arugula	31	0	0
106	Fresh produ	2012	Monterey	Watsonville	28	Arugula	78	0	0
107	Fresh produ	2012	San Benito	Hollister	21	Arugula	71	0	0

113	Fresh produce	2013	Monterey	Soledad	62	Arugula	71	0	0
114	Fresh produce	2013	Monterey	Soledad	60	Arugula	28	0	0
115	Fresh produce	2013	Monterey	Soledad	99	Arugula	109	2	0
116	Fresh produce	2013	San Benito	Hollister	34	Arugula	97	0	0
117	Fresh produce	2013	San Benito	Hollister	29	Arugula	118	0	0
118	Fresh produce	2013	San Benito	Hollister	31	Arugula	45	31	0
119	Fresh produce	2013	San Benito	Hollister	27	Arugula	194	1	3
120	Fresh produce	2013	San Benito	Hollister	25	Arugula	176	7	0
121	Fresh produce	2013	San Benito	Hollister	18	Arugula	145	1	0
122	Fresh produce	2013	San Benito	Hollister	36	Arugula	36	1	0
123	Fresh produce	2013	San Benito	Hollister	21	Arugula	25	0	0
124	Fresh produce	2007	Monterey	King City	37	Chard_Beets	188	0	0
125	Fresh produce	2007	Monterey	King City	39	Chard_Beets	271	0	0
126	Fresh produce	2007	Monterey	King City	61	Chard_Beets	84	0	0
127	Fresh produce	2007	Monterey	King City	53	Chard_Beets	7	0	0
128	Fresh produce	2007	Monterey	Greenfield	51	Chard_Beets	5	0	0
129	Fresh produce	2007	Monterey	King City	67	Chard_Beets	7	0	0
130	Fresh produce	2007	Monterey	Greenfield	73	Chard_Beets	34	0	0
131	Fresh produce	2007	Monterey	Soledad	56	Chard_Beets	1	0	0
132	Fresh produce	2007	Monterey	Soledad	78	Chard_Beets	6	0	0
133	Fresh produce	2007	Monterey	Soledad	65	Chard_Beets	11	0	0
134	Fresh produce	2007	Monterey	Soledad	62	Chard_Beets	154	0	0
135	Fresh produce	2007	Monterey	Gonzales	101	Chard_Beets	215	0	1
136	Fresh produce	2007	Monterey	Soledad	99	Chard_Beets	87	0	0
137	Fresh produce	2007	Monterey	Gonzales	89	Chard_Beets	76	0	0
138	Fresh produce	2007	Monterey	Gonzales	86	Chard_Beets	20	0	0
139	Fresh produce	2007	Monterey	Chular	43	Chard_Beets	105	0	0
140	Fresh produce	2007	Monterey	Chular	74	Chard_Beets	4	0	0
141	Fresh produce	2007	Monterey	Salinas	44	Chard_Beets	64	0	0
142	Fresh produce	2007	Monterey	Chular	95	Chard_Beets	41	0	0
143	Fresh produce	2007	Monterey	Chular	41	Chard_Beets	27	0	0
144	Fresh produce	2007	Monterey	Spreckels	79	Chard_Beets	37	0	0
145	Fresh produce	2007	Monterey	Chular	42	Chard_Beets	27	0	0
146	Fresh produce	2007	Monterey	Chular	94	Chard_Beets	15	0	0
147	Fresh produce	2007	Monterey	Salinas	98	Chard_Beets	36	0	0
148	Fresh produce	2007	Monterey	Salinas	75	Chard_Beets	23	0	0
149	Fresh produce	2007	San Benito	Hollister	34	Chard_Beets	311	0	0
150	Fresh produce	2007	San Benito	Hollister	30	Chard_Beets	178	0	0
151	Fresh produce	2007	San Benito	Hollister	31	Chard_Beets	146	0	0
152	Fresh produce	2007	San Benito	Hollister	23	Chard_Beets	94	0	0
153	Fresh produce	2007	Monterey	Watsonville	28	Chard_Beets	21	0	0
154	Fresh produce	2007	Santa Clara	Gilroy	12	Chard_Beets	160	0	0
155	Fresh produce	2008	Monterey	King City	37	Chard_Beets	103	0	0
156	Fresh produce	2008	Monterey	King City	39	Chard_Beets	173	1	0
157	Fresh produce	2008	Monterey	San Lucas	63	Chard_Beets	158	0	0
158	Fresh produce	2008	Monterey	King City	100	Chard_Beets	63	0	0
159	Fresh produce	2008	Monterey	King City	50	Chard_Beets	676	0	0
160	Fresh produce	2008	Monterey	Greenfield	51	Chard_Beets	1	0	0
161	Fresh produce	2008	Monterey	Soledad	62	Chard_Beets	252	0	0
162	Fresh produce	2008	Monterey	Soledad	99	Chard_Beets	87	0	0
163	Fresh produce	2008	Monterey	Chular	43	Chard_Beets	36	0	0



169	Fresh produce	2008	Monterey	Chular	94	Chard_Beets	4	0	0
170	Fresh produce	2008	Monterey	Salinas	75	Chard_Beets	35	0	0
171	Fresh produce	2008	San Benito	Hollister	34	Chard_Beets	366	0	0
172	Fresh produce	2008	San Benito	Hollister	30	Chard_Beets	231	0	0
173	Fresh produce	2008	San Benito	Hollister	19	Chard_Beets	62	1	0
174	Fresh produce	2008	San Benito	Hollister	31	Chard_Beets	79	0	0
175	Fresh produce	2008	Monterey	Watsonville	26	Chard_Beets	41	0	0
176	Fresh produce	2008	San Benito	Hollister	18	Chard_Beets	37	0	0
177	Fresh produce	2008	Monterey	Watsonville	33	Chard_Beets	17	0	0
178	Fresh produce	2008	Monterey	Watsonville	28	Chard_Beets	3	0	0
179	Fresh produce	2009	Monterey	San Ardo	40	Chard_Beets	186	1	0
180	Fresh produce	2009	Monterey	San Lucas	58	Chard_Beets	58	2	0
181	Fresh produce	2009	Monterey	King City	37	Chard_Beets	179	0	0
182	Fresh produce	2009	Monterey	King City	39	Chard_Beets	142	0	0
183	Fresh produce	2009	Monterey	San Lucas	63	Chard_Beets	419	2	0
184	Fresh produce	2009	Monterey	King City	50	Chard_Beets	587	3	0
185	Fresh produce	2009	Monterey	King City	68	Chard_Beets	31	0	0
186	Fresh produce	2009	Monterey	Greenfield	51	Chard_Beets	26	1	0
187	Fresh produce	2009	Monterey	Soledad	81	Chard_Beets	1	0	0
188	Fresh produce	2009	Monterey	Soledad	62	Chard_Beets	271	0	0
189	Fresh produce	2009	Monterey	Soledad	99	Chard_Beets	77	0	0
190	Fresh produce	2009	Monterey	Chular	43	Chard_Beets	2	0	0
191	Fresh produce	2009	Monterey	Salinas	44	Chard_Beets	20	0	0
192	Fresh produce	2009	Monterey	Gonzales	49	Chard_Beets	7	0	0
193	Fresh produce	2009	Monterey	Chular	41	Chard_Beets	41	0	0
194	Fresh produce	2009	Monterey	Salinas	98	Chard_Beets	9	0	0
195	Fresh produce	2009	Monterey	Salinas	59	Chard_Beets	13	0	0
196	Fresh produce	2009	Monterey	Salinas	46	Chard_Beets	28	0	0
197	Fresh produce	2009	Monterey	Salinas	75	Chard_Beets	25	0	0
198	Fresh produce	2009	San Benito	Hollister	25	Chard_Beets	51	0	0
199	Fresh produce	2009	San Benito	Hollister	18	Chard_Beets	731	0	0
200	Fresh produce	2009	Monterey	Watsonville	33	Chard_Beets	27	0	0
201	Fresh produce	2009	Monterey	Watsonville	28	Chard_Beets	49	0	0
202	Fresh produce	2009	Santa Clara	Gilroy	24	Chard_Beets	3	0	0
203	Fresh produce	2010	Monterey	King City	37	Chard_Beets	1	0	0
204	Fresh produce	2010	Monterey	King City	39	Chard_Beets	5	0	0
205	Fresh produce	2010	Monterey	King City	50	Chard_Beets	28	0	0
206	Fresh produce	2010	Monterey	King City	52	Chard_Beets	2475	5	2
207	Fresh produce	2010	Monterey	Soledad	62	Chard_Beets	3	0	0
208	Fresh produce	2010	Monterey	Gonzales	49	Chard_Beets	36	0	0
209	Fresh produce	2010	San Benito	Hollister	29	Chard_Beets	60	0	0
210	Fresh produce	2010	San Benito	Hollister	19	Chard_Beets	26	0	0
211	Fresh produce	2010	San Benito	Hollister	25	Chard_Beets	11	0	0
212	Fresh produce	2010	San Benito	Hollister	18	Chard_Beets	50	0	0
213	Fresh produce	2011	Monterey	San Ardo	40	Chard_Beets	378	0	0
214	Fresh produce	2011	Monterey	King City	37	Chard_Beets	286	0	0
215	Fresh produce	2011	Monterey	King City	39	Chard_Beets	156	0	0
216	Fresh produce	2011	Monterey	King City	38	Chard_Beets	20	0	0
217	Fresh produce	2011	Monterey	San Lucas	63	Chard_Beets	207	0	0
218	Fresh produce	2011	Monterey	King City	50	Chard_Beets	556	0	0
219	Fresh produce	2011	Monterey	King City	53	Chard_Beets	77	0	0

What was tested	Test Year	Test County	Nearest Town	Farm C-1	Crop	Total Tests	# Positive for EHEC	# Positive for Salmonella
Fresh produce	2007	San Benito	Hollister	31	Arugula	172	0	0
Fresh produce	2008	San Benito	Hollister	31	Arugula	2	0	0
Fresh produce	2009	San Benito	Hollister	31	Arugula	44	4	0
Fresh produce	2011	San Benito	Hollister	31	Arugula	51	0	0
Fresh produce	2012	San Benito	Hollister	31	Arugula	193	1	0
Fresh produce	2013	San Benito	Hollister	31	Arugula	45	31	0
Fresh produce	2007	San Benito	Hollister	31	Chard_ Beets	146	0	0
Fresh produce	2008	San Benito	Hollister	31	Chard_ Beets	79	0	0
Fresh produce	2012	San Benito	Hollister	31	Chard_ Beets	98	2	0
Fresh produce	2007	San Benito	Hollister	31	Chinese cab	67	0	0
Fresh produce	2008	San Benito	Hollister	31	Chinese cab	17	0	0
Fresh produce	2011	San Benito	Hollister	31	Chinese cab	38	0	0
Fresh produce	2012	San Benito	Hollister	31	Chinese cab	24	0	0
Fresh produce	2013	San Benito	Hollister	31	Chinese cab	45	31	0
Fresh produce	2007	San Benito	Hollister	31	Lettuce	120	0	0
Fresh produce	2008	San Benito	Hollister	31	Lettuce	342	0	0
Fresh produce	2007	San Benito	Hollister	31	Spinach	31	0	0
Fresh produce	2008	San Benito	Hollister	31	Spinach	153	3	0
Fresh produce	2009	San Benito	Hollister	31	Spinach	246	19	0
Fresh produce	2010	San Benito	Hollister	31	Spinach	54	1	0
Fresh produce	2011	San Benito	Hollister	31	Spinach	182	14	0
Fresh produce	2012	San Benito	Hollister	31	Spinach	103	20	0
Fresh produce	2013	San Benito	Hollister	31	Spinach	264	100	0

Figure: Karp et al., 2015, farm 31

What was tested	Test Year	Test County	Nearest Town	Farm Code	Crop	Total Tests	# Positive for EHEC	# Positive for Salmonella
Fresh produce	2009	Monterey	San Ardo	40	Arugula	110	0	0
Fresh produce	2011	Monterey	San Ardo	40	Arugula	103	0	0
Fresh produce	2013	Monterey	San Ardo	40	Arugula	87	13	0
Fresh produce	2009	Monterey	San Ardo	40	Chard_Beets	186	1	0
Fresh produce	2011	Monterey	San Ardo	40	Chard_Beets	378	0	0
Fresh produce	2012	Monterey	San Ardo	40	Chard_Beets	160	3	0
Fresh produce	2013	Monterey	San Ardo	40	Chard_Beets	77	0	0
Fresh produce	2009	Monterey	San Ardo	40	Chinese cab	157	0	0
Fresh produce	2011	Monterey	San Ardo	40	Chinese cab	281	0	0
Fresh produce	2012	Monterey	San Ardo	40	Chinese cab	128	0	0
Fresh produce	2013	Monterey	San Ardo	40	Chinese cab	276	10	0
Fresh produce	2009	Monterey	San Ardo	40	Cilantro	2	0	0
Fresh produce	2009	Monterey	San Ardo	40	Dill	1	0	0
Fresh produce	2012	Monterey	San Ardo	40	Kale_Cabba	99	6	0
Fresh produce	2013	Monterey	San Ardo	40	Kale_Cabba	171	4	0
Fresh produce	2009	Monterey	San Ardo	40	Lettuce	27	0	0
Fresh produce	2012	Monterey	San Ardo	40	Lettuce	501	0	0
Fresh produce	2013	Monterey	San Ardo	40	Lettuce	537	0	0
Fresh produce	2009	Monterey	San Ardo	40	Spinach	489	5	0
Fresh produce	2011	Monterey	San Ardo	40	Spinach	781	4	3
Fresh produce	2012	Monterey	San Ardo	40	Spinach	447	48	0
Fresh produce	2013	Monterey	San Ardo	40	Spinach	800	75	2

Figure: Karp et al., 2015, farm 40

Filter Options: [Clear Search Options](#)

Current Search: 1998 to 2016 13 Foods/Ingredients [Clear](#)

[Clear Search Option](#)

> Year

> State

> Etiology

> Setting

▼ Food/Ingredient [Clear](#)

Includes all foods/ingredients containing search text.

[Add](#)

☒ lettuce

☒ arugula

☒ cilantro

☒ chard

☒ chinese cabbage

☒ dill

☒ endive

☒ beets

☒ parsley

☒ radicchio

☒ combo mix

☒ mache

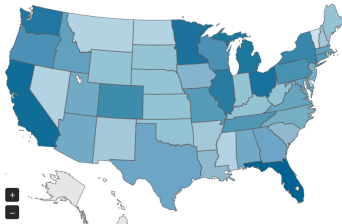
☒ spinach

This filter applies only to Food outbreaks.

These data were last updated 3/13/2018.

## Outbreaks per State

Display: [U.S. Map](#)



## Quick Stats - Current Search

**429** Outbreaks

**11,497** Illnesses

**692** Hospitalizations

**12** Deaths

## Quick Stats - Overall

**41,269** Outbreaks

**1,054,151** Illnesses

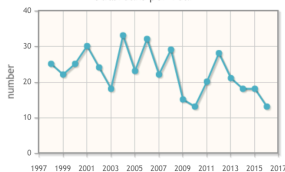
**27,909** Hospitalizations

**1,290** Deaths

Year

Display: [Outbreaks](#)

## Outbreaks per Year\*



Month

Display: [Outbreaks](#)

## Outbreaks per Month

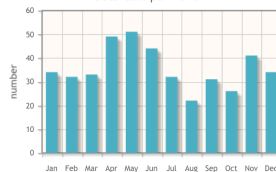


Figure: CDC produce-related outbreaks 1998-2016

# Estimated total costs from non-fatal and fatal bicycle crashes in the USA: 1997–2013

## Abstract

**Introduction** Emergency department visits and hospital admissions resulting from adult bicycle trauma have increased dramatically. Annual medical costs and work losses of these incidents last were estimated for 2005 and quality-of-life losses for 2000.

**Methods** We estimated costs associated with adult bicycle injuries in the USA using 1997–2013 non-fatal incidence data from the National Electronic Injury Surveillance System with cost estimates from the Consumer Product Safety Commission's Injury Cost Model, and 1999–2013 fatal incidence data from the National Vital Statistics System costed by similar methods.

---

**Results** Approximately 3.8 million non-fatal adult bicycle injuries were reported during the study period and 9839 deaths. In 2010 dollars, estimated adult bicycle injury costs totalled \$24.4 billion in 2013. Estimated injury costs per mile bicycled fell from \$2.85 in 2001 to \$2.35 in 2009. From 1999 to 2013, total estimated costs were \$209 billion due to non-fatal bicycle injuries and \$28 billion due to fatal injuries. Inflation-free annual costs in the study period increased by 137% for non-fatal injuries and 23% for fatal injuries. The share of non-fatal costs associated

Figure: Bicycle injury costs, BMJ

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- Who should be responsible? Farmers? USDA? Distributors? Retailers?

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