RELATIVE RISK OFANIMAL PRESENCE TO UNPROCESSED PRODUCE

Most cattle operations, some feral pigs, and relatively few wildlife, especially those associated with polluted areas, are a food safety concern. Wildlife have a low incidence of carrying pathogens, yet many well-intentioned efforts to make the growing environment "clean" have created misguided farm requirements, harmful to both food safety and land stewardship practices. Grasses and wetlands can filter microbial pollution, especially when the residence time for water flowing through the systems is prolonged. While nature can never provide zero risk, the benefits that habitat brings outweighs the drawbacks of a denuded farm.

SUMMARY TABLE **RELATIVE RISK TO UNPROCESSED PRODUCE FROM ANIMAL PRESENCE** **PREPARED BY WILD FARM ALLIANCE** **www.wildfarmalliance.org**			
DOMESTIC ANIMALS[1]	**FOOD SAFETY RISK**	**CURRENT SCIENCE WE KNOW**	**WHAT A FARMER CAN DO**
Cattle	Very High	Research shows cattle are major reservoirs of *E. coli* pathogens on the landscape. For *E. coli* pathogens in cattle farms and feedlots in the study areas, 63, 64, 75, 100, 100, 100, and 100% of the operations were positive with *E. coli* pathogens in 13 States and in Northwest U.S. In specific cattle herds within these and other operations, 0.3, 0.35, 0.7, 0.9, 1.0, 1.01, 1.25, 1.4, 1.8, 2.5, 3.7, 4.3, 6.9, 6.9, 13.4, 16.1, 19.7, 20.0, 21.0, 26.7, 27.3, 33.8, 53.0% were found to have *E. coli* pathogens in California, Kansas, Nebraska, North Dakota, Southern U.S., Texas, Washington, Wisconsin, Czech Republic, England, Norway, and Switzerland. For *Salmonella* pathogens, cattle were found with 1.25 and 7% in Texas and Colorado (see supporting data). Amounts of *E. coli* pathogens present in herds depend on the age of the cattle, season, and how management of feed, and of grazing lands can affect re-infection rates (Hancock et al. 1998a, Hancock and Besser 2006, Hussein 2007, Khaitsa et al. 2006, Knox et al. 2007, Kuhnert et al. 2005). Grasses and wetlands can filter up to 99% of *E. coli* in water (Knox et al. 2007, Tate et al. 2006). Pathogens in made compost containing cattle manure can exist for up to 150 days or longer under some conditions. The outside edges of improperly made compost are known to contain pathogens (Erickson et al. 2010).	Prevent pasture and rangeland runoff from direct contamination of cropland and water sources used for crop management. Keep grasses and other vegetated buffers between crops and grazing lands. Rest grazing areas at least a week prior to irrigation. Filter runoff through conserved and restored wetlands. Putting cattle on healthy grasslands, instead of in confined feeding areas, may reduce the incidence of *E coli* pathogens. Use certified compost or ensure compost made on the farm is turned evenly and the temperature is measured in multiple locations so that all parts reach proper temperature.

[1] Other domestic livestock, such as sheep, goats, and pigs, have been found at times to carry human pathogens, but further research is needed to determine the extent of the problem.

NON-DOMESTIC ANIMALS	FOOD SAFETY RISK	CURRENT SCIENCE WE KNOW	WHAT A FARMER CAN DO
Cattle (con't)	Very High	*E. coli* O157 can survive in dried conditions for long periods and be transferred in aerosols. Manure-laden *E. coli* O157 dust has made people sick at county fairs (Brabban 2004, Cooley et al. 2007). Pathogens like *E. coli* O157 are allowed to mutate and proliferate in confined animal feeding operations where unhealthy conditions and sub-therapeutic doses of antibiotics are given to make the animals gain weight quickly (Pew Charitable Trusts 2008).	Cattle loafing areas can be sites where manure is ground into dust and blown onto crops. Use hedgerows and windbreaks to reduce dust blowing in on the wind.
Feral (non native) Pigs	Moderately Low	In California, two studies documented 5% and 14.9% of feral pig samples containing *E. coli* O157 (see supporting data). These pigs were found in association with cattle. Feral pigs did not evolve in the U.S. and so are not compelled to hide from natural predators, although they may learn to hide from hunters. Since they are highly mobile on large home ranges, removing habitat is not an effective control strategy (Jay and Wiscomb, 2008). Feral pigs compete with native wildlife for resources and can help to destroy fragile ecosystems in wild areas.	Monitor cropped field for feral pig intrusion and define a no-harvest zone if fecal matter is present. Hunt feral pigs, or if continuously present in large numbers, install a short, hog wire fence. Do not remove habitat; it will not dissuade the animals.
WILDLIFE			
Deer	Low	For *E. coli* pathogens, deer were found with 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0.25, 0.3, 0.4, 0.64, 0.7, 0.79, 1.5, 1.8, and 2.4% in California, Kansas, Louisiana, Nebraska, Oregon, Texas, Washington, Wisconsin, Wyoming, Southern US, Norway, and Sweden. Higher results of 9% came from a small study in Oregon where deer feces, not colon swabs, were collected; and of 23.9% from Spain where a mix of European elk, deer, and mountain sheep results were reported together. For *Salmonella* pathogens, deer tested positive 0, 0, 1, and 7.69% in Nebraska, Texas, Norway and Sweden (see supporting data).	Since the incidence of deer carrying *E. coli* O157 is low, removing habitat that protects water quality is counterproductive and the cost would not appear, at this time, to be justified. Providing an inexpensive feeding attractant away from cropped areas may reduce intrusion. If unusually high deer activity is detected in the field, consider discouraging animals with loud noises, motion sensors, food attractants placed in other areas, and fencing as a last resort (fence only the growing fields, not the whole farm).

WILDLIFE	FOOD SAFETY RISK	CURRENT SCIENCE WE KNOW	WHAT A FARMER CAN DO
Rodents	Moderate	Rodents near buildings, confined animal feeding operations, and polluted areas are sometimes found carrying human pathogens. Rodents were found with 0 and 40% *E. coli* pathogens on dairy farms and cattle feedlots, respectively. Mice and rats tested positive 16.2% for *Salmonella* pathogens on chicken layer farms (see supporting data).	See p. 14 about rodents in or near storage areas. Do not grow crops eaten raw next to areas of concentrated cow manure.
Field Rodents	Low	*E. coli* pathogens were prevalent in rodents 0, 0, 1.4, and 20% (2 out of 10 rodents on cattle farms). According to UC Cooperative Extension, it is hard to justify extensive trapping, baiting, fencing, and vegetation clearing for the specific purpose of reducing animal (rodent) vectoring of *E. coli* O157, unless future research findings indicate otherwise (Salmon et al. 2008). Field rodents can be a significant food quality risk for processed crops because of the possibility of being chopped up into the harvest (see supporting data).	Since the incidence of field rodents carrying *E. coli* O157 is low, removing habitat that filters pathogens in water is counterproductive.
Birds Near Cattle Feedlots, Cattle Ranches, Dairy Farms or Polluted Areas	Low	Some of the time some birds near cattle and other pollution sources do carry *E. coli* and *Salmonella* pathogens, but the prevalence is low. For *E. coli* pathogens, birds near cattle or pollution were found with 0, 0, 0, 0, 0.5, 0.9, 1, 1.6, 2.2, 2.9, 3.3, 3.6, 5, and 5.4% in California, Kansas, Nebraska, Ohio, Pacific Northwest, Washington, Wisconsin, Czech Republic, Denmark and England. For *Salmonella* pathogens, birds near cattle or pollution were found with 0, 0.7, 9, and12.9% in Colorado, Kansas and Scotland (see supporting data).	While some birds can be a low risk, it may be prudent when growing freshly eaten crops near cattle or polluted areas, to not plant (or at least not harvest) in areas where birds consistently perch directly over the planted beds. Since the incidence of birds carrying *E. coli* and *Salmonella* pathogens is low, removing habitat that filters pathogens in water is counterproductive.
Birds Not Near Cattle or Pollution	Very Low	No birds were found with *E. coli* pathogens in study areas not near cattle or pollution: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, and 0% in Colorado, Massachusetts, New Jersey and Virginia and Sweden. For *Salmonella* pathogens, a few birds were found with low levels of 0.6, 4, and 4% in New Jersey, Virginia, and Wisconsin (see supporting data).	Even though birds not associated with cattle are a very low food safety risk, monitoring for high bird populations and when found creating a non-harvest zone in this area may be wise.

WILDLIFE	FOOD SAFETY RISK	CURRENT SCIENCE WE KNOW	WHAT A FARMER CAN DO
Amphibians and Reptiles	Low	Pathogens are known to be associated with amphibians and reptiles when exposed to abnormally high doses and when in unnatural areas, but the practical significance of this information for farmers is limited (Lowell et al. 2010). Frogs were found to shed *E. coli* O157 during specific lifecycle stages, but they had been inoculated with abnormally high levels under laboratory conditions (Gray et al. 2007). Kids and adults have been infected with *Salmonella* when handling their caged pets, which are often kept in unclean enclosures (Mermin et al. 2004) or in zoos (Bauwens et al. 2007). The cause of an outbreak with *Salmonella* tainted orange juice was never determined even though rodent and bird droppings were found inside the juice processing plant and one toad carrying the pathogen outside (Cook et al. 1998). No *Salmonella* was found in wild reptiles in Virginia (see supporting data).	Since amphibians are attracted to water, ensure that nearby riparian areas are not unnaturally depleted of water during the crop season. Conserve habitat.
Insects	Low	Studies show that flies can be vectors of *E. coli* pathogens from infected manure to crops, but data on the practical significance or relationship to outbreaks is unknown. For *E. coli* pathogens, 0, 3.33, 3.4, 5, 17, and 61% were found in Central California, Southern California, Wisconsin and Denmark. While fly regurgitation found on spinach had persisted for one week in the lab, it is unknown if it would persist in the field. It is thought flies tend to stay close to manure source unless they are drawn into a produce field by other food source, such as honeydew excreted by aphids.	Do not grow crops eaten raw next to areas of concentrated cow manure. Do not harvest crops impacted by high populations of flies close to harvest.

This document provides guidelines and practical tools for use by family farmers. It is intended as an educational resource and not as technical advice tailored to a specific farming operation, or, even though it reflects food safety guidance from the FDA, as a substitute for actual regulations and guidance from FDA or other regulatory agencies. It is also not intended as legal advice. We cannot guarantee that use of these guidelines and tools will: (i) eliminate the risk of pathogenic contamination of fresh fruits and vegetables; (ii) eliminate the risk of harm to human and environmental health; (iii) enable a grower to comply with all applicable legal requirements, buyer sourcing requirements or processing contract terms; (iv) defend successfully against legal claims; (v) reduce insurance costs; or (vi) sell into new markets. This document also identifies websites and other resources for possible use by growers. WFA does not endorse and is not responsible for the availability or content of these resources. WFA will not be responsible or liable, directly or indirectly, for any consequences resulting from use of this document or any resources identified in this document. WFA is providing this document to family farmers as an educational service.

SUPPORTING DATA[2, 3]

DOMESTIC ANIMALS

Cattle Found with *E. coli* Pathogens

Branham et al. 2005, livestock grazing in **Texas**

1.25% (1/80)

Chapman et al. 1997, 4,800 tests of cattle in **England**

13.4% of beef cattle

16.1% of dairy cattle

Cizek et al. 1999, fecal samples of cattle in feedlot in the **Czech Republic**

20% (72/365)

Faith et al. 1996, dairy cow manure in **Wisconsin**

1.8% (10/ 560) calves

3.7% (19/51) follow-up testing

Fischer et al. 2001, cattle in **Southern U.S.**

4.3% (13/305)

Hancock et al. 1998a, cattle in confined animal feeding operations (CAFO) in **13 States**

63% (63/100) of beef cattle feedlots with one or more samples testing positive

75% (27/36) of dairy herds with highest herd prevalence of 10 - 26.7%

Hancock et al. 1998b, cattle on farms in the **Northwest U.S.**

100% (12/12) farms with 1.1% to 6.1% prevalence within herds

Hancock, et al. 1997, cattle herds

64% (9/14) of herds, with overall herd prevalence of 1·0%, with higher amounts in the summer months.

Hussein et al. 2005 feedlot and range cattle

0.3 to 19.7% in feedlot cattle

0.7 to 27.3% in cattle on irrigated pasture

0.9 to 6.9% in cattle grazing rangeland forages

Jay et al. 2007, cattle on rangeland in **California**

33.8% (26/77)

Johnsen et al. 2001, intestinal contents from 1,541 cattle in **Norway**

0.35% (n=1,541)

Khaitsa et al. 2006, seasonal shedding of *E. coli* O157: H7 in feedlot cattle in **North Dakota**

1.4% (2/144) cattle in October

6.9% (10/144) cattle in November

21 – 53% (30/143 – 76/143) cattle twice in March

Kuhnert et al. 2005, organically and conventionally managed dairy cows in **Switzerland**

100% (60/60) STEC on organic dairy farms

100% (60/60) STEC on conventional dairy farms

25% (15/60) *E. coli* O157: H7 on organic dairy farms

17% (10/60) *E. coli* O157: H7 on conventional dairy farms

LeJeune et al. 2008, cow manure in Ohio

2.5% (48/1869)

Renter et al. 2003, fecal samples of cattle on ranches in **Kansas** and **Nebraska**

1.01% (92/9122)

Cattle Found with *Salmonella* Pathogens

Branham et al. 2005, livestock grazing in **Texas**

1.25% (1/80)

Pedersen et al. 2006, dairy manure in **Colorado**

7% (8/120)

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[2] When available, data is presented as a percentage of animals with pathogens, and then in parentheses with the first number corresponding to the number of animals testing positive, and the second the total animals tested.

[3] Where possible, a distinction is made between samples taken with swabs from trapped animals and from the colons of dead animals, versus those taken from the ground where they could have been contaminated by other animals, or multiple feces could have been deposited by the same animal.

NON- DOMESTIC ANIMALS

Feral Pigs Found with *E. coli* Pathogens

Jay et al. 2007, necropsy swabs and fecal samples from the ground of feral pigs on cattle rangeland in **California**
    14.9% (13/87)

Jay-Russell et al. 2010 trapped and killed or hunter harvested feral pigs on cattle ranches and nearby produce fields in **California**
    5% (10/200)

WILDLIFE

Deer Found with *E. coli* Pathogens

Branham et al. 2005, fecal and rumen samples of white-tailed deer near livestock grazing in **Texas**
    0% (0/26) *E. coli* O157: H7

California Department of Fish and Game 2009, hunter harvested black-tailed deer in **California**
    0% (0/311)

Dunn 2004, 3 studies of hunter harvested white-tailed deer in **Louisiana**
    0.3% (n=338)
    1.8% (n=55), captive in summer
    0.4% (n=226) captive year average

Fischer et al. 2001, 3 studies of deer with cattle nearby (both hunter harvested and feces on the ground) in **So. U.S**.
    0% (0/310)
    0.64% (3/469)
    0.7% (1/140)

Garcia-Sanchez 2007, deer rectal swab in **Spain**
    1.5% (n=206)

Jay et al. 2010, hunter harvested black-tailed deer in produce fields and on cattle ranches in **California**
    0% (0/19)

Keene et al. 1997, black-tailed deer feces on the ground in **Oregon**
    9% (3/32)
    0% (0/3), 4 months later

Lillehaug et al. 2005, hunter harvested deer in **Norway**
    0% (0/135) red deer
    0% (0/206) roe deer
    0% (0/150) raindeer

Olsen et al. 2002, fecal samples of deer in **Wyoming**
    0% (0/5 includes deer and elk samples)

Renter et al. 2003, ground scat and from hunter harvested deer near range cattle in **Kansas** and **Nebraska**
    0% (0/141)

Renter 2001, hunter harvested white tailed deer in **Nebraska**
    0.25% (4/1,608)

Rice et al. 2003, white tailed deer fecal samples
    0.79% (5/630)

Samadpour et al. 2002, fecal samples of deer near cattle in **Washington**
    0% (0/2)

Sanchez et al. 2009, deer in **Spain**
    23.9% (58/243, includes deer and 2 other species)

Sargaent et al. 1999, wild white-tailed deer fecal samples taken near cattle ranches in **Kansas**
    2.4% (5/212)

Shere et al. 1998, guts of deer near dairy farm in **Wisconsin**
    0% (0/89 includes deer and 9 other non deer species)

Wahlstrom et al. 2003, hunter harvested roe deer in **Sweden**
    0% (0/791 includes roe deer and 5 other non deer species)

Deer Found with *Salmonella* Pathogens

Branham et al. 2005, fecal and rumen samples of white-tailed deer near livestock grazing in **Texas**
    7.69 % (2/26)

Lillehaug et al. 2005, hunter harvested deer in **Norway**

0% (0/135) red deer
0% (0/196) roe deer
0% (0/153) reindeer
Renter 2006, hunter harvested white tailed deer in **Nebraska**
1% (5/500)
Wahlstrom et al. 2003, hunter harvested roe deer in **Sweden**
0% (0/791 includes deer and 5 other species)

Rodents Found with *E. coli* or *Salmonella* Pathogens
Cizek et al. 1999, stool samples of rats associated with **cattle feedlot** in the **Czech Republic**
40% (4/10) Norway rat *E. coli* O157
Henzler and Opitz 1992, rodents on **chicken layer farms** in **Maine**
16.2% (116/715) mice & rats *Salmonella* pathogens
Shere et al. 1998, guts of mice and rats near a **dairy** in **Wisconsin**
0% (1/89 includes multiple other species) *E. coli* O157

Field Rodents Found with *E. coli* Pathogens
Hancock et al., 1998b, live caught rodents on cattle ranches in the **Pacific Northwest**
0% (0/300)
Jay-Russell et al. 2010 trapped and release wild mice, voles and pack rats on nearby produce fields and cattle ranches in **California**
1.4% (1/72) deer mouse
Nielson et al. 2004, fresh rodent feces on cattle farms in **Denmark**
20% (2/10)
Rice et al. 2003, rodents in an undisclosed location
0% (0/300)

Birds Found Near Cattle or Polluted Areas with *E. coli* Pathogens
Cizek et al. 1999, fresh feces of birds nearby cattle feedlot in the **Czech Republic**
0% (0/50) pigeon
0% (0/20) sparrow
Gaukler et al. 2009, cloacal swabs of birds associated with a feedlot in **Kansas**
0% (0/434) European starlings
Hancock et al., 1998b, feces of wild birds on cattle ranches in the **Pacific Northwest**
0.5% (1/200)
Jay-Russell et al. 2010, colonic fecal samples or swabs from birds on cattle ranches and nearby produce fields in **California**
5.4% (5/93) American crows
3.3% (2/60) brown-headed cowbirds
LeJeune et al. 2008, guts of birds near a dairy farm in **Ohio**
2.2% (7/316) European starlings
Nielson et al. 2004, bird feces near cattle and pig farms in **Denmark**
1.6% (4/244) two tree sparrows, one barn swallow and one European starling
Renter et al. 2003, fecal samples of wild birds near cattle ranches in **Kansas** and **Nebraska**
0% (0/9)
Samadpour et al. 2002, ducks, cows and other species near a lake in **Washington**
5% (1/20) one duck
Sanderson et al. 2006, feces of birds from in a cattle feedlot
3.6 % (6/165) unknown bird species
Shere et al. 1998, guts of pigeons, turkeys, sparrows, starlings near a dairy in **Wisconsin**
1% (1/99) one pigeon
Wallace et al., 1997, fresh feces of Herring gull, black-headed gull, and common gull, crow, and jackdaw in two locations in **England**
2.9% intertidal zone
0.9% landfill

Birds Found Near Cattle or Polluted Areas with *Salmonella* Pathogens

Fenlon, 1981, seagull feces near sewage outfalls and lakes in **Scotland**, the former of which had the highest rates (17-21%)

12.9% (160/1,242)

Gaukler et al. 2009, cloacal swabs of birds associated with a feedlot in **Kansas**

0.7 % (3/434) European starlings

Pedersen et al. 2006, cloacal swabs of rock pigeons in two locations in **Colorado**

9% (9/106) dairy farms

0% (0/171) urban areas

Birds Not Near Cattle or Polluted Areas Found with *E. coli* Pathogens

Converse et al., 1999, bird feces in non-agricultural areas of **Massachusetts**, **New Jersey** and **Virginia**

0% (0/360) goose

Kullas et al. 2002, bird feces in **Colorado**

0% (0/397) goose

Palmgren et al. 1997, stool samples of birds in **Sweden**

0% (0/101) passerines

0% (0/50) seagulls

Rice et al. 2003, birds in an undisclosed location

0% (0/121) Canada geese

0% (0/67) trumpeter swan

0% (0/150) gull

0% (0/20) duck

0% (0/124) European starling

0% (0/83) wild turkey

Wahlstrom et al. 2003, hunter harvested geese and seagulls in **Sweden**

0% (0/791 includes geese and 5 other species)

Birds Not Near Cattle or Polluted Areas Found with *Salmonella* Pathogens

Converse et al., 1999, bird feces in non-agricultural areas of **Massachusetts**, **New Jersey** and **Virginia**

0.6% (2/360) goose

Palmgren et al. 1997, stool samples of birds in **Sweden**

4% (2/50) seagulls

Wahlstrom et al. 2003, hunter harvested birds in **Sweden**

4% seagulls

Amphibians and Reptiles Found with *E. coli* and *Salmonella* Pathogens

Gray et al. 2007, two ages of American bullfrog inoculated with high levels of *E. coli* O157 in **Tennessee** lab.

0% tadpoles in flow-through aquaria

54% metamorphs placed in stagnant aquaria (stale water used to speed up experiment)

Richards et al. 2004, cloacal swabs from free-living reptiles in **Virginia**.

0% *Salmonella* for 34 eastern box turtles, 14 eastern painted turtles, 14 snapping turtles, 6 black rat snakes, 2 redbelly turtles, 2 yellowbelly sliders, 2 eastern garter snakes, and 1 eastern river cooter.

Insects Found with *E. coli* Pathogens

Nielson et al. 2004, insects on cattle and pig farms in **Denmark**

0% (0/6) pooled insect samples

Rice et al. 2003, rodents in an undisclosed location

3.33% (2/60) pooled flies

Sanderson et al. 2006, houseflies in a cattle feedlot

3.4% (53/1,540) housefly

Shere et al. 1998, flies caught in a fly trap on a dairy in **Wisconsin**

5% (1/20)

Talley et al., 2009 filth flies fly captured in leafy green fields in **Central California**

61% (11/18)

Wayadande 2010, flies that fed on inoculated manure or bacterial lawns and then regurgitated onto spinach in **Southern California**.

17% (17/98) of pooled flies *E. coli* O157:H7

APPENDIX II: REGULATIONS PROTECTING NATURAL RESOURCES[4]

This table has been created to help producers understand federal and state regulations in order for them to educate their food safety inspectors/auditors. If a producer believes that their food safety inspector/auditor is suggesting or requiring an action that is contrary to these regulations, please contact the applicable agency immediately.

REGULATIONS PROTECTING NATURAL RESOURCES			
AGENCY	**WHAT IT PROTECTS / REGULATES**	**WHY IT IS IMPORTANT TO PROTECT**	**WEBSITES FOR MORE INFORMATION**
USDA National Organic Program	Soil, Water, Wetlands, Woodlands, and Wildlife	Conserves fertile soils, ensures water quality, helps to recharge groundwater and alleviate flooding, and protects native species and ecosystems important to agricultural production and the larger landscape.	www.wildfarmalliance.org http://attra.ncat.org/attra-pub/summaries/OSPtemplates.html
State and Federal Wildlife Agencies	Threatened and endangered plants and animals and their habitats. Migratory birds.	Helps to address the biodiversity crisis.	www.fws.gov/offices/statelinks.html
National Marine Fisheries Service	Threatened and endangered anadromous fish species (i.e. salmon, trout, sturgeon) and their habitats	Helps to address the biodiversity crisis.	www.nmfs.noaa.gov/
Environmental Protection Agency and State Water Agencies	Water quality	Helps to provide clean water resources and supplies for human and wild communities.	http://epa.gov/agriculture/water.html
US Army Corps of Engineers	Modifications to surface waters under USACE jurisdiction, such as: disposal of materials into water, adding or fixing a culvert, regrading slopes, and filling in wet depressional areas.	Helps to conserve riparian areas, recharge groundwater and alleviate flooding.	www.usace.army.mil/

4 The regulations presented here are not meant to be an exhaustive. More detailed information can be obtained from the agencies themselves.

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