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**Center for Produce Safety STEC Seasonality Project:
Romaine Lettuce Seasonal Risk in the California Central Coast Region**
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CPS STEC Issue Brief 3: Regional Cattle Management Profile



Introductory Statement: Two facts are unequivocal in the search for understandings towards prevention and mitigation of Shiga toxin-producing *E. coli* (STEC) outbreaks associated with romaine lettuce and other leafy greens, and the regional integrity of specialty crop land use along the California Central Coast. First, the primary reoccurring subtype of *E. coli* O157:H7 (rEcO157) has been found in cattle manure and mixed soil and manure within the implicated region in consecutive years. Second, this serious human pathogen subtype found its way to regional specialty crop growing locations, implicated

by traceback data, resulting in contamination of product at some point within the timeline of production and/or harvest. In this Issue Brief, the focus is on romaine lettuce, but this term will include all leafy greens within the context of general associations between domesticated animal management and crop production within the CA Central Coast.

Throughout this project, identifying common, overlapping seasonal activities is essential to analyze relationships between specific regional cattle management, local area herd management, and the variable seasonality of these practices (See Table 1). In particular, group or herd movement at a specific locale during lot-specific timing of romaine lettuce production and harvest is a critical missing piece to analyze root cause within the context of the cattle and leafy greens interface. There are clear mechanisms and potential vectors for dispersal of rEcO157 from rangelands to romaine production lots (See CPS STEC Issue Brief 1: Hypothesis Risk Matrix). However, a definitive singular or combined route of transference associated with any outbreak-implicated lot has eluded the considerable efforts directed at this issue to date.

Table 1. Best fit approximation of seasonality in the Central Coast cattle management

Key Hypothesis Generation-related Activity	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Seasonal Calving and Weaning	Variable	Variable	Variable	Variable	Peak	Peak	Peak	Variable	Variable	Variable	Variable	Variable
Grazing of stocker cattle in pastures on annual grasses	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak
Grazing within buffer zone areas or adjacent leafy greens	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak
Movement of Cow-calf pairs and Stocker cattle (hillsides; pastures)	Continual: Ranch and Conditions Dependent											
Supplemental hay – Rainy-season dependent	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak
Supplemental feed tubs with added molasses	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak
Congregation (water trough, salt blocks, branding, shade trees)	Constant: Density variable and weather dependent											
Influx of bulls for breeding	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak
Culling of herd for market (congregation at corrals, sales yards and video auctions)	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak

Variable levels/ activity
 Peak seasonality or activity
 Limited activity
 Uncommon

Profile of Regional Cattle Management

Cattle husbandry has been part of the CA Central Coast landscape since the 1840s, with large herds managed on large land grant ranchos, generally exceeding 13,000 acres. With the arrival of railcar shipping in the late 1800s, much of the flat, arable land was converted to crop production, but it wasn't until the late 1930s that leafy greens acreage began to expand. The regional beef cattle ranching industry has maintained a presence, but with many fluctuations, and currently is reported to be less than 4 percent of the 13

million total acres of public and private land supporting cattle stock management in California. In Monterey County, the focus of the CPS STEC project, this equates to less than one head per 18 acres for the 49,000 cattle in the county (adapted from NASS 2017). Cattle grazing and rangeland management is largely restricted to land not suitable for specialty crop production but can be closely co-located in the region. This has been especially true for converting land to produce crop production when other areas became limited or to qualify ground for organic production. Profitability in modern cattle management is often tenuous and many ranchers are diversified in their overall operations, including leafy greens and other specialty crop production.

The challenges in elucidating the risk exposure for food safety in leafy greens include where cattle are specifically located, at what seasonal proximity density, engaged in what herd management practices, which environmental conditions are experienced during the leafy greens season, and the specifics of regional, local, and locale herd movement. These will be briefly discussed later in this document.



Figure 1. Two views of rangeland grazing along the California Central Coast region and proximity to leafy greens production. The mere presence of cattle adjacent to farms or to land uses nearby (undefined term) has not been associated with a definitive qualitative or quantitative probability of an outbreak or detection of STEC in product sampling. Positive recovery of the clinically defined outbreak subtype of *E. coli* O157:H7 (rEcO157; See CPS STEC Issue Brief 4: Genomics and SNPs) from environmental deposits of cattle manure were reported by FDA at ~2 miles (cattle grate) and 1.3 miles (public roadway) from an implicated regional area. Distances to a specific romaine lettuce ranch block or sub-lot were not provided. Based on industry analysis, possible production locations were likely more separated from sampled sites. The produce industry understands the need to better characterize and control these hazards and risk factors by establishing scientifically developed data to support sound policies, practices, and preventive measures.

Risk potential has been described in terms related to proximity, including *adjacent* and *nearby*, particularly as a point of reference to detection of the rEcO157 in 2019 and 2020 by FDA-led

investigative teams. Adjacent is an accepted spatial distance concept in discussions of produce safety systems and risk potential (closely adjoining, abutting, or common side). Nearby is a more contentious term in discussions of outbreak investigative reports and spatial separation of romaine production from areas of rangeland and pasture grazing. Specific proximity, as a mitigation measure based on prescribed setback distance metrics, may not always be an effective preventive prerequisite when considering the foraging range of known vectors.

Primary Cattle Management in the CA Central Coast

The regional cattle industry has two primary profiles of cattle management. By acreage and position, the focus region is largely devoted to cow-calf operations in which breeding cows are maintained to produce calves. Calves are weaned, commonly after seven months, and moved to feeding operations, typically until they reach one-year. These grazing and pasture stocker operations receive interstate and intrastate cattle from diverse but generally consistent sources. The yearlings are fattened on seasonal green pasture and rangeland and dry forage before consolidation and movement to feedlots, typically in the Midwest. The region has one concentrated animal feeding operation (CAFO), periodically holding 1,000 or more cattle, and a number of small cattle corrals. A variety of sales methods are used, but all depend on consolidating cattle within transfer corrals (See Resources for links to details of the California industry).

Cattle Movement: Rangeland grazing cattle are periodically and seasonally relocated and sometimes consolidated for various purposes, including sale, branding, castrating, and dehorning, and at supplemental feeding sites if natural forage is limited due to a low rainfall year. Animal handlers take measures to minimize stress and activity/excitement in a holding or staging area (e.g., Stull et al. 2007, Beef Care Practices). Long-distance movement, whether intrastate, domestic interstate, or longer distances by ocean or air transport, may also be very stressful to the animals. While many factors influence the abundance and shedding of STEC, stress and elevated temperatures, in addition to diet, are known to be major contributors (Sapountzis et al. 2020).

Transfer corrals dot the length of the Salinas Valley on both sides of the Salinas River, but their density and outbreak-traceback relevancy is greater in the southern end along the same corridors as leafy greens production. Many of these small facilities are in closer proximity than the majority of grazing cattle populations. Apart from logical hypothesis development, there is no specific evidence or data attributing romaine contamination to direct transfer during movement to or short-term holding in these corrals.

The one notable feedlot in the region of interest has been identified by FDA, however there is no available information to specifically characterize risk potential or exposure

from this operation to outbreak, recall, or crop testing data related to this CPS STEC project.



Figure 2 – Corrals and transfer stations are found throughout the CA Central Coast region and on both sides of the Salinas Valley along the Salinas River corridor in the same manner as specialty crop production, including romaine lettuce. Animal receiving and shipping facilities are found where romaine contamination has been implicated in a reoccurring seasonal pattern but equally where there has been a historical and current recognized absence of STEC detection on product. The proximity of these congregation and animal handling sites alone does not, currently, adequately explain root cause for rEcO157 contamination.

It was surprisingly challenging to acquire data and analysis specific to the tracking and tracing of cattle movement into and around the CA Central Coast. During hypothesis generation discussions and debate, one resource (Gear et al. 2013) gave us some hope that Interstate Certificate of Veterinary Inspection (ICVI) and intrastate records might provide insights to analysis of the cattle import and intrastate movement. This information was viewed as potentially integral to source-tracking and a deeper understanding of the evolutionary relatedness and diversification of the clade and rEcO157 sub-clade relationships (See CPS STEC Issue Brief 4: Genomics and SNPs). However, more recent overviews or data synthesis of ICVIs and state/county level inspections were not found or accessible.

Movement of cattle may take various forms, including stock trailers, tractor trailers designed for livestock and which generally have two levels. These vehicles may share a

common public roadway or private farm road near crop production fields. The relevance and risk potential of these interfaces currently remain uncharacterized.



Figure 3. In general, other than herding to or from transfer stations and small corrals, daily movement of cattle near specialty crop production is among small groups with limited bioaerosol generation. Unlike the daily peak of “fugitive dust” (aerosolized feedlot surface materials) at CAFOs, bioaerosols dispersing from rangelands have not been adequately characterized. Observations of bioaerosol generation within the CA Central Coast, however, do not support a level of airborne particulates that would likely represent a convincing root cause risk due to the dilution effects over current setback distances. We can largely discount the prevalent initial speculation on bioaerosols from hillside rangelands to explain romaine contamination, apart from aggregation locations where cattle are much closer to leafy greens production. However, ruling this in or out, in general or at a specific location, has not been scientifically determined. There are some exceptions in the region where larger numbers of cattle are herded from hillsides to pastures and pass closely by leafy greens production sites. However, outbreak traceback has not implicated ranch blocks or lots where this seasonal herd movement has occurred for many years.

In the broad characterization of import and intrastate cattle movement, shipment of cattle from long-standing sources tends to be transactional and consistent with limited multi-rancher destinations from a single herd. An example of this type of movement of calves to pasture and rangeland stocker operations for finishing (400 to 500 lb to 800 to 1,000 lb) is between Hawaii and California destinations on ocean vessels in dual deck “cowtainers.” Preconditioning guidance practices are generally practiced, minimizing negative animal-health impacts of long-distance shipping. In general, cattle are shipped

to specific stocker operations along the CA Central Coast and rarely split between county and operation destinations. As a rule, individual or small herd movement between counties is limited, including between neighboring operations.



Figure 4. An example of a “cowtainer” used for marine shipment of cattle to rangeland stocker and feedlot operations on the mainland.

Why is this potentially relevant? Acquiring greater shared understanding and granularity of cattle imports, interstate, and intrastate movement is considered a necessary data set to give future efforts an opportunity to understand and resolve issues surrounding the high degree of similarity and year-to-year limited diversification of rEcO157. Are these isolates now established as residents in an operation(s) and always present in regional herds and environmentally? In contrast, are they seasonally introduced from a specific source(s) networked to but outside the regional system? Are the rEcO157 established in a persistent alternative animal feeding operation supplying manure for compost, such as out-of-county dairies, and re-introduced seasonally with fall manure and compost applications? Have the rEcO157 developed an elevated alternative host adaptation (known to occur within the accessory genome) that provides persistence but limited diversification? Current alignment of facts and dates tend not to support this later hypothesis, but we just don't know or have the information to provide these insights.

Congregation and Proximity: For the region, movement and shipments are generally small, less than 100 head and more typically less than 10. The seasonality of cattle congregation may be strongly influenced by year-to-year conditions, which may necessitate “culling” of the herd when forage is limited due to low rainfall during winter

and early spring. Herd culling has been typified by drought conditions along the CA Central Coast, including during 2021. Under these conditions, experienced frequently in recent years, the seasonal increase in proximity of cattle to certain romaine production locales has occurred earlier in the main season. These facts have been suggested as possible scenarios for the shifting timeline of earliest onset dates for clinical cases in consecutive years (See CPS STEC Issue Brief 4 for a timeline of outbreaks by month of onset). Despite a significant effort with industry partners during this project, we could not align these timelines and congregation sites with outbreak traceback specifics. In future, achieving this granularity of data is necessary to rule in or out the specific risk factors identified during hypothesis generation.

On-site and map-based analysis and discussions with growers and cattle managers, during this CPS project, identified that animal congregation sites were of greater interest relative to understanding risk. Cattle will naturally congregate at sites based on need, such as supplement feeding locations, water troughs, and shade. When herded together in close confines, animals may be subjected to stresses that may influence shedding behaviors. Many articles in published and peer-reviewed journals describe these factors and their influence on STEC prevalence in manure and within a herd. These details are beyond the scope of this Issue Brief but were reviewed over the course of this project.



Figure 5. Various congregation sites, in addition to transfer corrals, such as water troughs and natural shading, are under consideration as key sites for persistent populations of rEcO157 and other STEC of concern. Water troughs are typically not in close proximity to crop production but, seasonally, cattle may be moved to sites adjacent or nearby to romaine crops.

Heat stress is of interest as a factor impacting herd aggressiveness and fecal elimination traits. Cattle habitually are more active during immediate post-dawn and pre-dusk periods. During periods of exceptional heat, cattle activity and potential for generating localized bioaerosols at congregation sites increases at dusk prior to evening grazing. In grazing herds, supplemental feed is provided during periods of low forage abundance or nutritional quality. Ranchers utilize various well-studied methods for placement of supplement feeding stations, which may include hay, alfalfa, molasses and urea, to best distribute the herd and reduce aggressiveness at these sites.

Reducing the Risk at the Source

Regional cattle are certainly a source of the rEcO157 genomic clusters and subtypes isolated across the CA Central Coast region, but a definitive direct source or indirect source of transference to romaine is not yet clear. There has been renewed interest in the possibility of reducing risk by sustainably reducing shedding and prevalence of STEC and *E. coli* O157:H7 by herd vaccination. This topic is beyond the scope of this Issue Brief, but background and a research example is provided by Schmidt et al. 2018 (See Resources). An interim review of discussions and strategies around reducing rEcO157 and other *E. coli* O157:H7 strains is provided by the California Agricultural Neighbors workgroup (See Resources), which includes a background and current regional cattle vaccination research efforts approach within the California [Longitudinal Study](#) (FDA 2021).

Resources

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