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Identifying Concentrated Animal Feeding Operations Location and Proximity to Impaired Streams in California

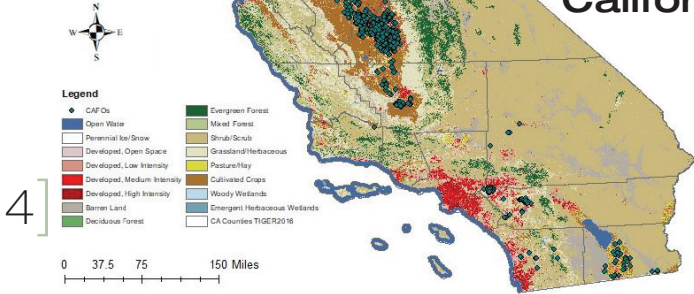


Figure 1: CAFO locations and EPA 303d Impaired and assessed streams in California in ArcGIS.

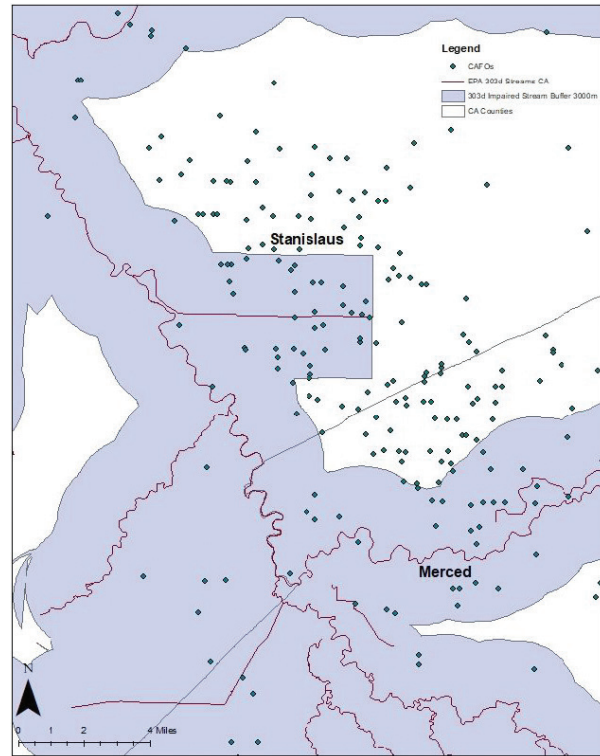


Figure 2: EPA 303d Listed Impaired Stream with a 3000m buffer and CAFOs in Merced and Stanislaus Counties, Central Valley.

Livestock production has transitioned from pasture to large building facilities that house high densities of cattle, poultry, and swine called Concentrated or Confined Animal Feeding Operations (CAFOs) (Burkholder et al., 2007; Heaney et al. 2015; Mallin & Cahoon, 2003; Mallin et al. 2015). Waste produced by livestock in CAFOs are collected in wet lagoons or dry piles outside the facilities where it is applied on adjoining fields by aerial spray or subsurface injection. As a result, CAFO waste often introduces excessive nutrients, microbial pathogens, and pharmaceuticals to water at the application site and in surrounding waterways (Burkholder et al., 2007; Mallin & Cahoon, 2003; Mallin et al. 2015). Additionally, humans working in or living near these facilities have experienced adverse health effects including respiratory and infectious diseases from exposure to ammonia (NH₃), *E. coli* and arsenic associated with livestock waste (Hooiveld et al. 2016; Heaney et al. 2014; Liu et al. 2015; Wilson and Serre 2007). Despite these findings, Mallin et al. (2015) notes that US livestock production laws are ineffective in protecting surface water resources and related habitats.

The objective of this study is to identify and spatially illustrate the location of CAFOs in California, their proximity to impaired surface waters listed on the US Environmental Protection Agencies (EPAs) 303(d) list and communities defined as “Pollution Burden” (i.e. affected by and vulnerable to multiple pollution sources) by the CA Office of Environmental Health Hazard Assessment (OEHHA) CalEnviroScreen tool (OEHHA, 2019). Data included: National Pollution Discharge Elimination System (NPDES) Animal Feeding Facility permits, 2011 National Land Cover Data, 2016 Census Tiger County files, the CalEnviroScreen 3.0 geodatabase and EPA WATERS geospatial files. Data

Buffer Distance (meters)	100	200	300	1000	3000	6000
Cumulative Percent of CAFOs	2.5%	4.2%	7%	20.5%	47.1%	78.2%

Each buffer distance is in relations to an impaired stream. 100 meters are equivalent to 500ft, 0.67 miles.

Table 1: Cumulative Percentage of CAFOs by Proximity to Impaired Streams.

were imported into ArcGIS 10.4.1 to create CAFO points and 100, 200, 300, 1,000, 3,000 and 6,000 meter buffers around impaired stream segments. CAFOs located within these buffers were clipped to determine the number of facilities located within a fixed distance from an identified impaired stream segment (Figures 1 and 2). These layers were spatially aligned with the CalEnviroScreen geodatabase to identify community characteristics and environmental health risk (e.g. poor air and water quality) of communities with high densities of CAFOs and impaired stream segments.

Results indicate that a majority of NPDES permitted CAFOs (78 percent of the total) are located within 6,000m of an impaired stream in California and 47 percent of the total CAFOs are located within a 3,000m of an impaired stream (Table 1, Figure 2). Although CAFOs are found within all regions of California, high densities occur in the Central Valley on agricultural land types in Tulare, Merced, and Stanislaus Counties (Table 2, Figure 2). CAFOs are also located near urban centers in Marin County, north of San Francisco, and the cities of Ontario and Chino in Southern California (Figure 1). Counties with the highest number of CAFO facilities (Table 2) were ranked in the 91-100 and 81-90 percentiles according to the CalEnviroScreen, especially in relation to poor air and water

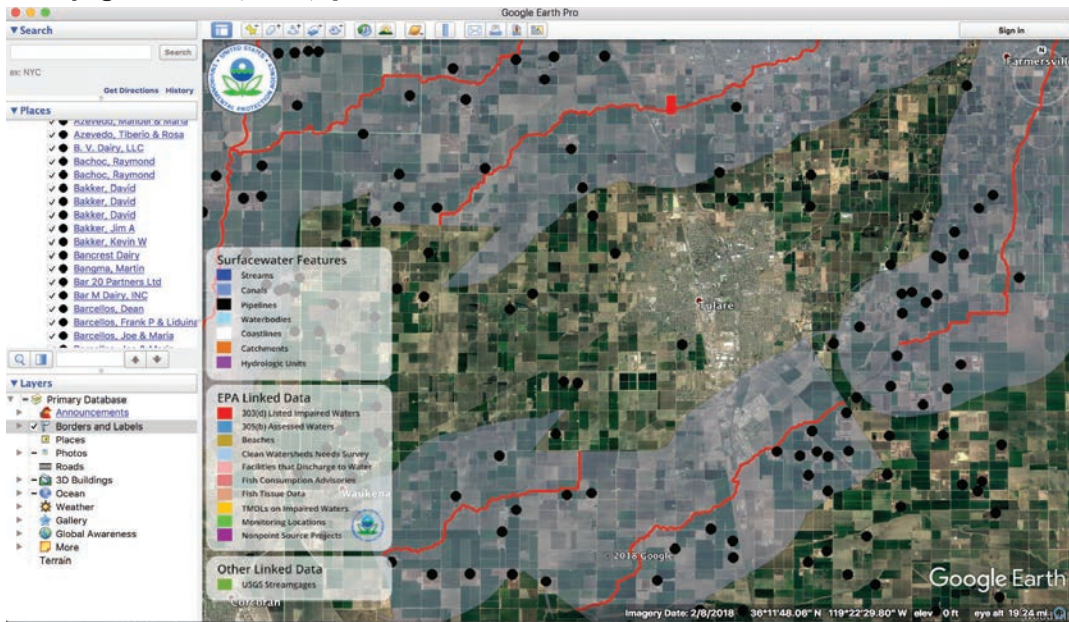


Figure 3: ArcGIS files displayed in Google Earth with 303d Impaired Streams, CAFOs and Stream Buffers.

County	number of CAFOs	Region
Tulare	306	5F – Central Valley
Merced	256	5S – Central Valley
Stanislaus	234	5S - Central Valley
Kings	175	5F – Central Valley
San Joaquin	118	5S- Central Valley
San Bernardino	87	8 - Santa Ana
Fresno	74	5F – Central Valley
Kern	69	5F – Central Valley
Sonoma	69	1 – Northern Coast
Humboldt	64	1 – Northern Coast

Ranking of Counties with the top 10 number of CAFOs with their county and respective regions. n=1,452 CAFOs

Table 2: Ranking of CA Counties by total CAFOs.

quality metrics. In addition, these locations have populations with 16%-25% of children under 10 years of age who are vulnerable to the exposure to excessive pollution sources. Results suggests that CAFO related activities in these locations could be contributing to these environmental and public health characteristics.

Once the initial analysis was completed, ArcGIS files were converted to KML files and imported into Google Earth to provide an interactive platform for engaging stakeholders in understanding spatial relationships between CAFOs, impaired surface water resources and “pollution vulnerable” communities (Figure 3). This project is ongoing and the socioeconomic characteristics of hydrological units with high densities of CAFOs and impaired streams are being assessed. Currently, the Google Earth based files are used in course activities for students to surf their watershed and explore the spatial context of impaired streams, CAFOs and communities impacted by various pollution sources across multiple geographical scales.

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