Descriptive Title: Smart Farming: Monitoring the health, welfare and location of individual hens in large commercial flocks using environmental acoustics.

Rationale for high risk/high reward: The last decade has seen an advancement in technologies employed to track animal movement and status (i.e. health, body condition, etc.). These technologies have pioneered the way for automated monitoring approaches termed precision livestock farming (PLF). PLF systems allow farmers to monitor changes in the production, health and welfare of individuals in real time, providing them with the ability detect and address problems as they arise, and to align management decisions to meet the needs of individuals. Investment in PLF innovations, as well as other agricultural technologies, has been identified as an area of interest for UC Davis, as evidenced by the selection of "SmartFarm" as one of the top contenders of the Big Idea campaign. Within this framework, this high risk/high reward project brings together scientists with expertise in poultry management and welfare, and sensor development and validation to collect proof-of-concept data on the feasibility of using environmental acoustic signatures to monitor the health (physiological state), welfare (changes in activity patterns) and location of individual hens housed in large commercial flocks.

With the increase in alternative hen housing systems, and those that allow outdoor access, it has become increasingly important to understand how changes in housing impacts the health and welfare of poultry. This knowledge is particularly critical for California producers, who have been leading the industry in the implementation of alternative housing systems. As the majority of PLF innovations have been within the dairy and swine industries, California's poultry producers currently have a limited ability to identify and address problems within the new systems in real time. The discrepancy in innovation efforts directed at poultry likely reflects monitoring difficulties caused by the small size of the birds, and related to tracking similarly looking individuals within very large flocks (up to the 100,000s). While there has been some development of sensor technology to track hen movement, the existing methods are not problem free. Many rely on video to track patterns of the flock (therefore, do not provide information at the individual level) or electronic technologies that are incompatible with poultry housing systems (ex. other birds and objects within the environment interfere with signals). The development of hen-mounted acoustic sensors and acoustic monitoring systems offers a novel approach with the potential for mitigating these problems. For instance, sensors can be placed under the feathers, reducing damage from pecking, and allow continuous recording of hen location compared to sensors that require readers in fixed locations. These devices can also be quite small, easily automated, and do not need external readers, compared to devices used now.

Overall Goal: Our long-term research objective is to obtain a USDA grant to develop and validate small, hen-mounted acoustic sensors and complementary analysis systems for monitoring changes in the health, welfare and locations of individual hens housed on commercial farms.

Specific Objectives: This project aims to establish proof-of-concept for the use of acoustic sensors for tracking individual hen location and movement within commercial barns (changes in which can be indicative of welfare problems), and physiological parameters (health status). Specific aims are to:

1. demonstrate the potential for acoustic sensors to detect changes in hen movement between indoor and outdoor acoustic environments, as well as unique acoustic environments within the barn;
2. demonstrate the feasibility of using sensors to monitor specific locations of hens within a barn by detecting sounds played outside of the hens' hearing ranges, and demonstrate that the sounds do not alter hen behavior;
3. demonstrate the feasibility of using external acoustic sensors to detect physiological parameters (ex. respiration rate) as has been shown possible for larger species.