

# Resources for abundance and density estimation in wild pigs

VerCauteren, Davis, Pepin, Snow

[kurt.c.vercauteren@usda.gov]

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## Methods for estimating abundance and management impacts

### Aerial gunning data can be used to evaluate management effectiveness

**Description:** We developed a method to evaluate feral swine population size and the impact of management activities on the population using aerial gunning management data. This method can be used to demonstrate the efficacy of aerial gunning on a property. Additionally, it provides an estimate of the population size before and after aerial gunning actions.

**Products:**

- We developed a user-friendly Excel app where managers can enter their own aerial gunning data and get a report of the impact of their management actions. Email [Amy.J.Davis@usda.gov](mailto:Amy.J.Davis@usda.gov) for a copy.
- **Publication:** Davis, A. J., M. B. Hooten, R. S. Miller, M. L. Farnsworth, J. Lewis, M. Moxcey, and K. M. Pepin. 2016. Inferring invasive species abundance using removal data from management actions. *Ecological Applications* **26**:2339-2346. <https://doi.org/10.1002/eap.1383>

### Using trapping data to evaluate management effectiveness

**Description:** We used trapping data to estimate feral swine population sizes, determine the impact of management actions, and show the estimated population size remaining after removal efforts.

**Products:**

- **Reports:** We produced reports for state directors and agency collaborators based on trap removal results for: Kansas, Missouri, South Carolina, Oklahoma, Mingo National Wildlife Refuge, and Wichita Mountains National Wildlife Refuge [**need to update with an accessible product**]

### Using management removal data to evaluate management effectiveness

**Description:** Building on previous work, Davis and Pepin are currently working with MO elimination program to develop a method for using collector's app data from all types of management actions to estimate abundance over time and identify the removal intensity needed to reach elimination. A key challenge for the program is to figure out where resources should be stationed to reach objectives. Our models will help guide these choices.

**Products:**

- **Publication:** Davis, A. J., R. Farrar, B. Jump, T. Guerrant, P. Hall, K.C. VerCauteren, and K. M. Pepin. In Prep. Not compromising efficacy for evaluation – providing management evaluations using management data

### A comparison of feral swine density estimation methods

**Description:** We compared population density estimators for feral swine that use cameras, trapping, and biomarkers. Estimates from removal trapping do well except when the population density is very low. Population density can be estimated well from artificial or naturally marked populations using camera traps.

### Products:

- **Publication:** Keiter, D. A., A. J. Davis, O. E. Rhodes, F. L. Cunningham, J. C. Kilgo, K. M. Pepin, and J. C. Beasley. 2017. Effects of scale of movement, detection probability, and true population density on common methods of estimating population density. *Scientific reports* 7:9446. <https://www.nature.com/articles/s41598-017-09746-5>

## Comparing the costs and biases associated with feral swine density estimation methods

**Description:** As a companion to the work comparing density estimators, we examined the cost effectiveness of different density estimators for feral swine. This method include genetic mark-recapture of fecal samples, as well as camera traps, and removal sampling. Camera traps are the least expensive. Genetic mark-recapture was the most expensive but that cost depended greatly on access to a lab.

### Products:

- **Publication in review:** Davis AJ; Keiter DA; Kierepka EM; Sloomaker C; Piaggio AJ; Beasley J; Pepin KM. A comparison of cost and quality of three methods for estimating density for wild pig (*Sus scrofa*). *Scientific Reports*. In Review.
- **Web application to determine cost effective method:**  
<https://ajdavis.shinyapps.io/costapp2/>

## Summaries of methods for estimating abundance and density for wild pigs and typical estimates using these methods

**Description:** Book chapters that summarize the methods we've developed for estimating abundance and density (with additional resources) and a summary of recently estimated abundance and density in wild pig populations in the USA.

### Products:

- **Publication:** Snow NS, Miller RS, Beasley JC, Pepin KM. 2020. Chapter 4: Wild pig population dynamics *in* *Invasive Wild Pigs in North America: Ecology, Impacts and Management*, VerCauteren KC et al. (Editors), CRC Press, Taylor & Francis Group, Boca Raton, FL, Pp 57-82.
- **Publication:** Beasley JC, VerCauteren KC, Lavelle M, Piaggio A, Kilgo J, Pepin KM, Keiter D. 2020. Chapter 9: Research methods for wild pigs in *Invasive Wild Pigs in North America: Ecology, Impacts and Management*, VerCauteren KC et al. (Editors), CRC Press, Taylor & Francis Group, Boca Raton, FL, Pp 199-228.

## Assessing elimination

### Determining elimination probability from camera data

**Description:** In areas with sparse feral swine population, we can estimate the change in the distribution of feral swine on the landscape, evaluate the impact of management

actions on feral swine occurrence, and estimate the probability that feral swine are eliminated from an area.

**Products:**

- **Publication:** Davis, A.J., R. McCreary, J Psiropoulou, G. Brennan, T. Cox, A. Partin, K.M. Pepin. 2018. Quantifying site-level usage and certainty of absence for an invasive species through occupancy analysis of camera-trap data. *Biological Invasion*. **20** (4): 877-890. <https://link.springer.com/article/10.1007/s10530-017-1579-x>

### Detection and persistence of environmental DNA for feral swine

**Description:** The modeling group assisted the genetics group in the analysis necessary to develop and evaluate the method for collecting and processing environmental DNA (eDNA) for detecting feral swine.

**Products:**

- **Publication:** Williams, K. E., K. P. Huyvaert, K. C. Vercauteren, A. J. Davis, and A. J. Piaggio. 2018. Detection and persistence of environmental DNA from an invasive, terrestrial mammal. *Ecology and Evolution* **8**:688-695. <https://doi.org/10.1002/ece3.3698>

### Optimizing environmental DNA sampling designs to determine feral swine elimination

**Description:** We determined the probability of detecting feral swine using environmental DNA (eDNA). It is important to know the probability of detecting eDNA to be able to say with confidence if feral swine are present in an area by only sampling eDNA. We determined the optimal field and lab sampling design to maximize detection while minimizing effort.

**Products:**

- **Publication:** Davis, A.J., K.E. Williams, N.P. Snow, K.M. Pepin, A.J. Piaggio. 2018. Accounting for observation processes across multiple levels of uncertainty improves inference of species distributions and guides adaptive sampling of environmental DNA. *Ecology and Evolution*. **8**(22): 10879-10892. <https://doi.org/10.1002/ece3.4552>
- **Web application to compute sample size:** [https://ajdavis.shinyapps.io/edna\\_app/](https://ajdavis.shinyapps.io/edna_app/)