Analysis of Feral Pig (*Sus scrofa*) Movement in a Hawaiian Forest Ecosystem Using GPS Satellite Collars

Lasha-Lynn H. Salbosa
Dr. Christopher A. Lepczyk

University of Hawaiʻi at Mānoa
Dept of Natural Resources & Environmental Management

94th Ecological Society of America Annual Meeting

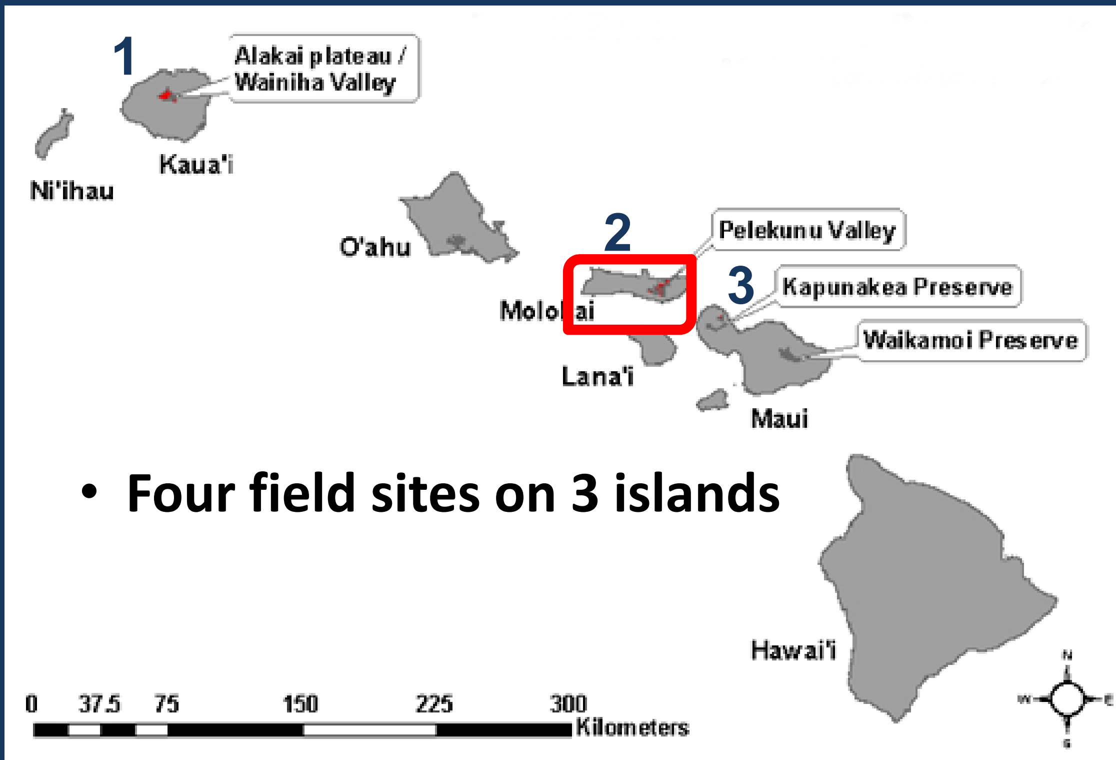
Problem

- Many of Hawaii's fragile ecosystems cannot sustain current numbers of pig populations
- Fences to exclude ungulates cannot be built across all terrain and vegetation types

Strategy

- Need to understand the following:
  - **Home range size & landscape factors of influence**
  - Resource selection & habitat use
  - Response to hunting pressure
  - Ingress rate & population growth

Overview of Larger Study



- **Four field sites on 3 islands**

- Initial temporal duration 120 days

* Feral pigs at these sites were displaced from their capture location in order to test natural/man-made barriers, thus could not be included in the home range comparison study

- **Due to logistical/wildlife constraints and technological failures numbers of collars recovered differed from numbers planned**

Field Site	Planned	Deployed	Recovered
Kauai – Wainiha Valley	10	8	2*
Molokai – Pelekunu Valley	10	12	4 (+1 displaced)
W. Maui – Kapunakea	10	10	8*
E. Maui – Waikamoi	10	8	8*
Total	40	38	23

• Currently, there are several problems that complicate refining home range estimation, including technological/cost constraints, and software limitations. More research is needed to recommend different techniques of home range estimation following the research question to be answered; given that an understanding of an animals' home range is an integral part in constructing effective wildlife management strategies.

Goal

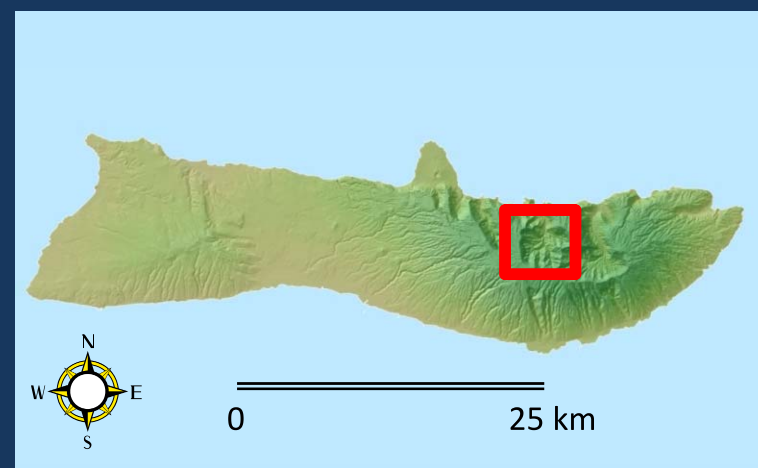
- Determine an effective home range estimation method and provide recommendations to improve feral pig management

Objective

- Evaluate 5 different methods of home range estimation using GPS collar relocation data obtained from feral pigs (*Sus scrofa*) within an island-forested habitat

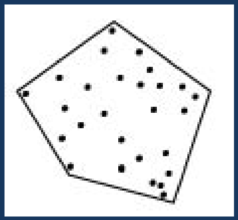
Methods

- Quantum 5000 GPS collars (Telemetry Solutions); weighing 700 g (with 40 cm round collar)
- Recorded every 15 minutes
- All feral pig handling contracted to animal control company Prohunt Ltd.
- Study site:
  - 23 km^2 open system
  - Elevation from sea level to 400 m
  - Mesic to wet montane forest

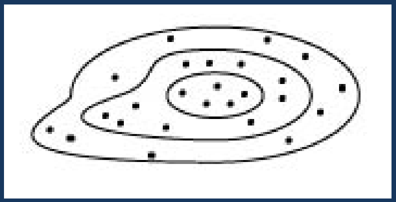


HR Estimation Techniques Analyzed

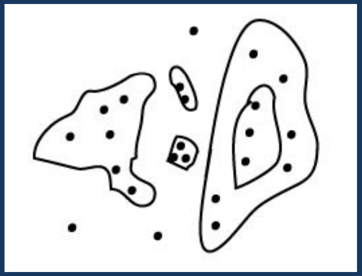
1. Minimum Convex Polygon (MCP)
   - **HR as a convex polygon encircling observed locations**



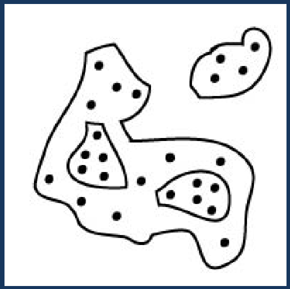
2. Kernel Density Estimation (KDE) – *href*
   - **Beginning of the home range as a utilization distribution expressed as isopleths of space use, based on average covariance of coordinate locations**



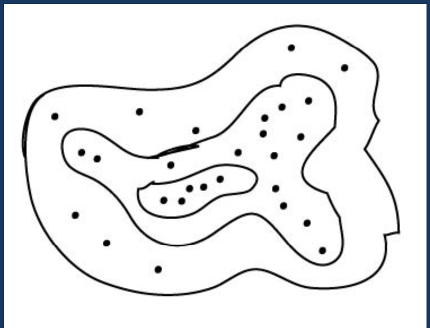
3. Kernel Density Estimation (KDE) – least squares cross-validation (LSCV)
   - **Smoothing parameter (kernel) based on minimizing the mean integrated square error**



4. Kernel Density Estimation (KDE) – likelihood cross-validation (CV)
   - **Kernel based on minimizing derivative of log-likelihood function**



5. Brownian Bridge (BB)
   - **Based on the variance of the animal's speed and a constant describing telemetry error**



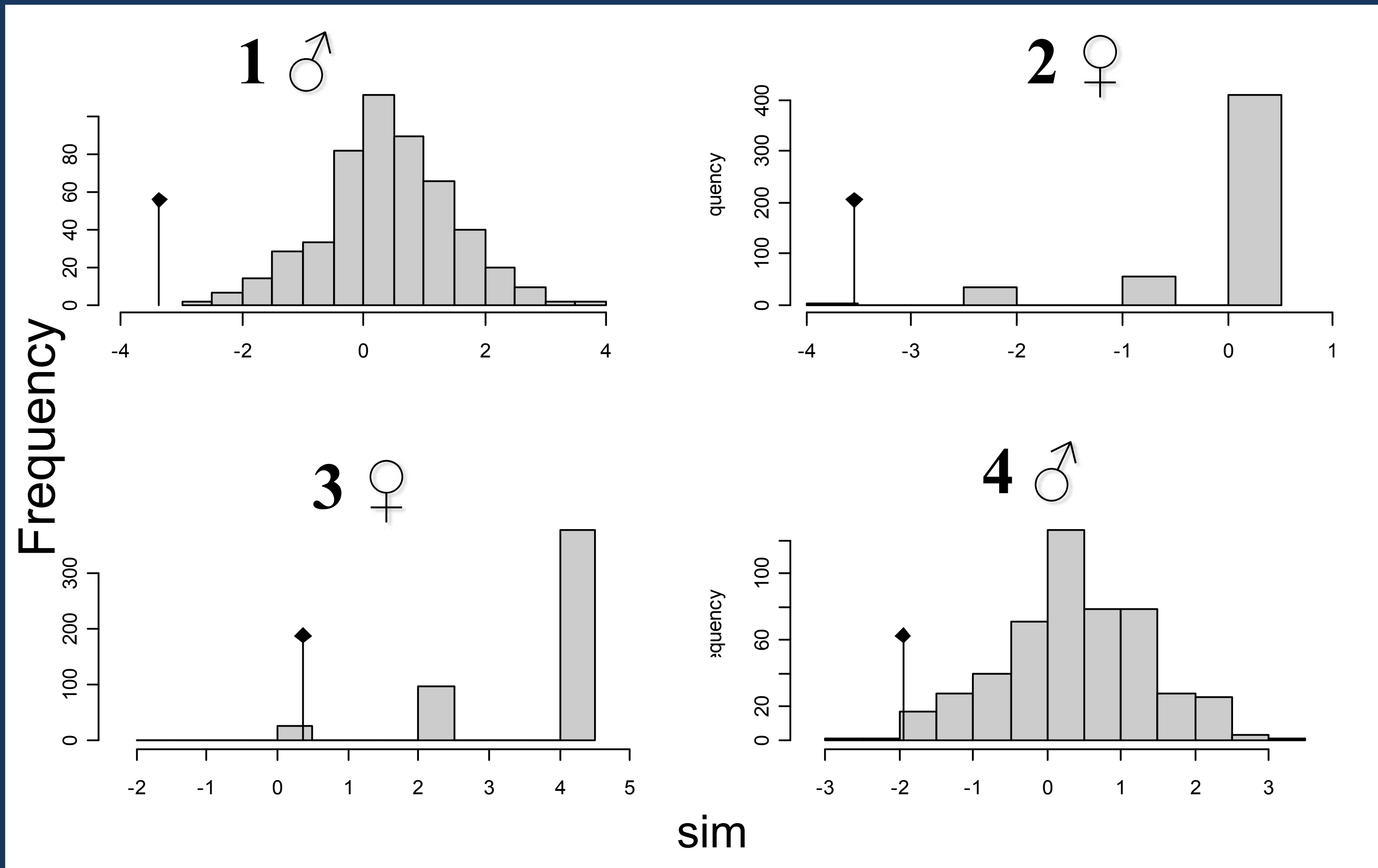
Results

Collared Subject	♀/♂	Mass (kg)	Fix Attempts	Successful Fixes	Successful Fixes (%)	Fate
1	♀	4.5	4,272	3,161	74%	dispatched after 96 days
2	♀	36.3	1,681	456	27%	found deceased after 31 days
3	♂	49.9	2,301	122	5%	found deceased after 38 days [a]
4	♂	54.4	2,042	643	31%	found deceased after 36 days

- Average temporal scale 50.25 days (SD=30.6 days)
- 34% rate of successful fixes; remaining 66% of fix attempts failed due to combination of unknown factors

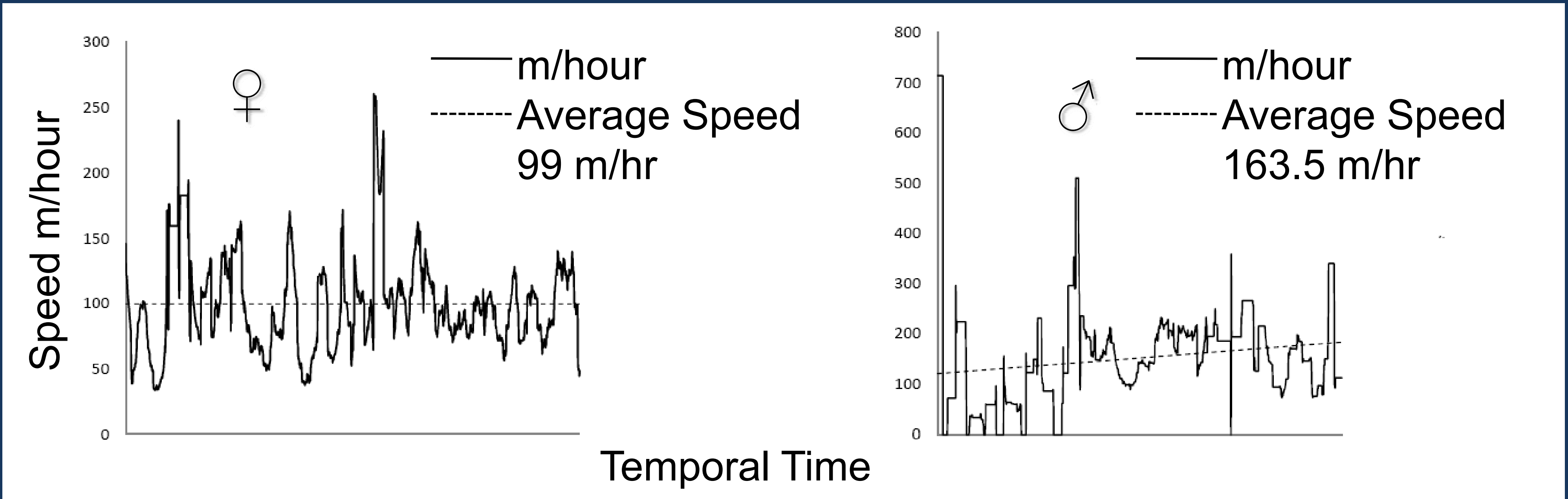
[a]Collared subject 3 may have died due to unknown reasons days after collaring

Frequency Distribution of Missed Fixes



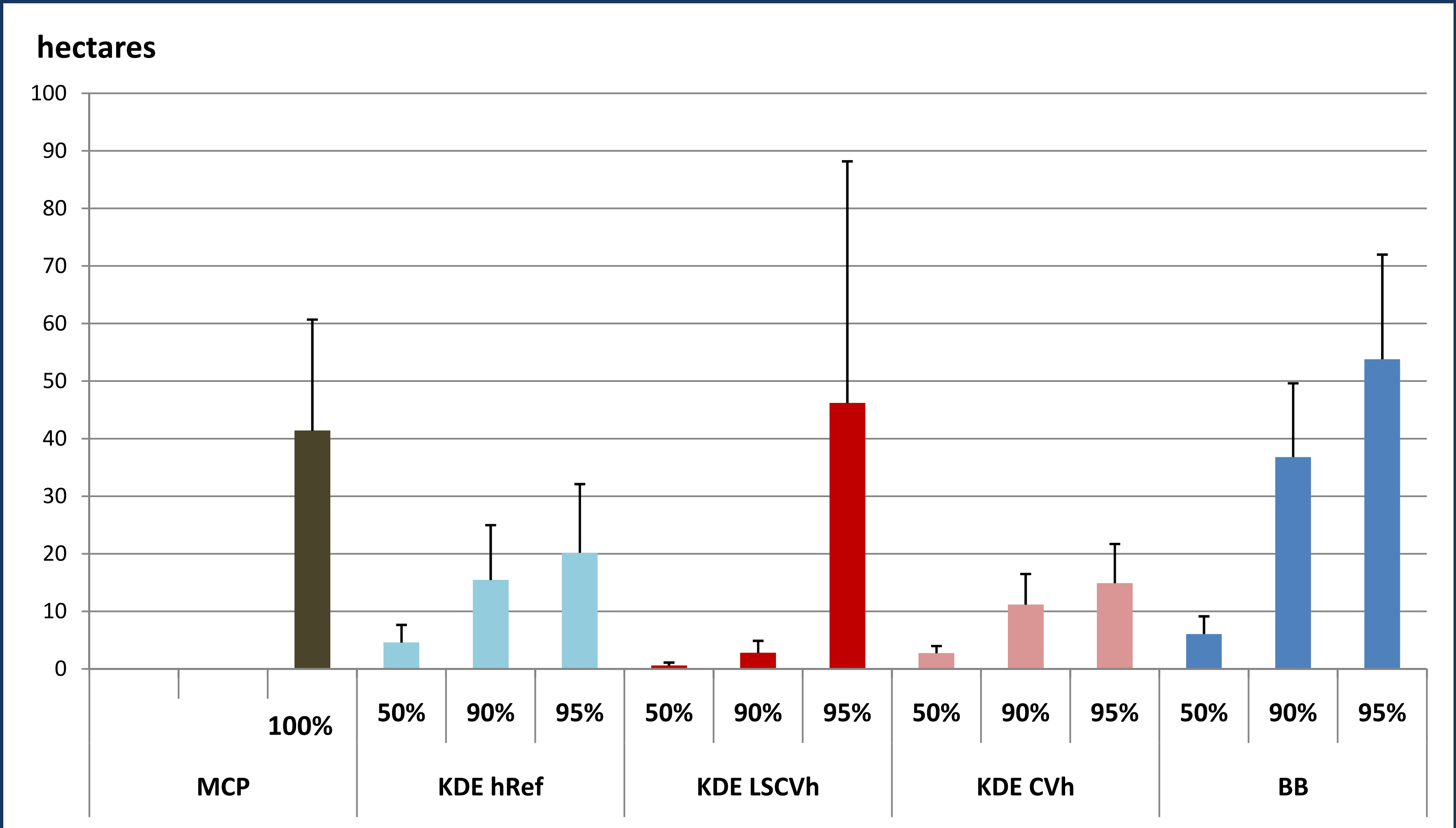
- **Frequency distribution of missed fixes were analyzed over the study period and were found to have normal random distribution, as would be expected.**
- **Frequency distributions of missed fixes at randomly chosen days *suggests* different behavioral patterns (e.g. wallowing or bedding) may differ by gender that in turn influence the success rate of GPS fixes. Whereas boars exhibited normal random distributions, missed location fixes for the sows occurred at specific periods of the day.**

Speed Trajectories



- Speeds ranged from 99 m/hr to 185 m/hr
- Sows maintained a constant rate of speed; whereas boars had a steady increase in speed throughout study duration
- Both sexes exhibited a freeze and hide strategy, immediately after release

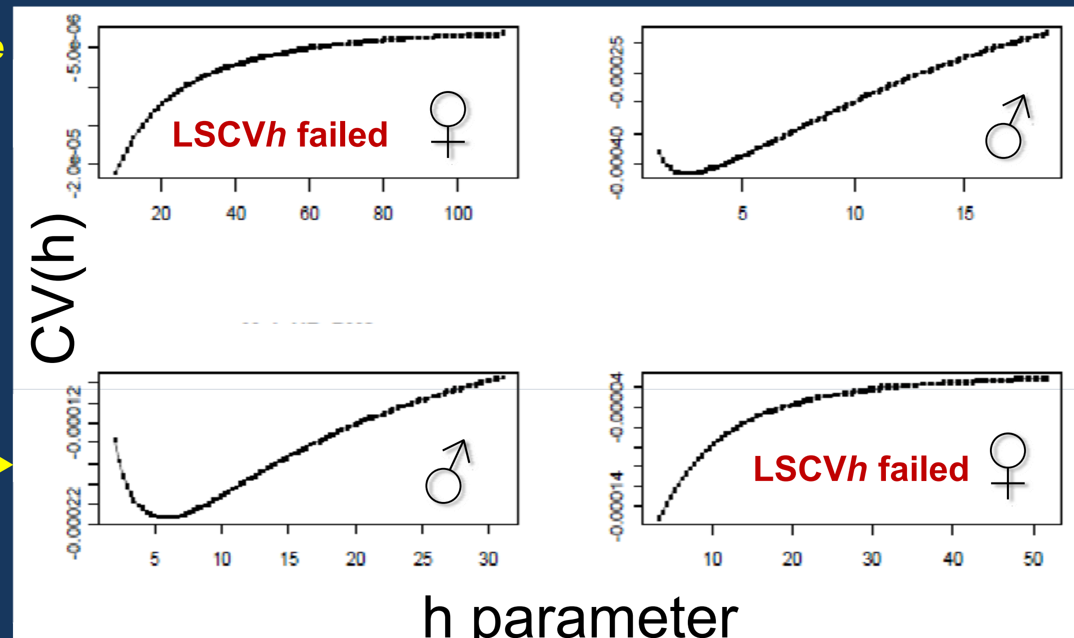
HR Method Estimates by Utilization Distribution (UD) Level

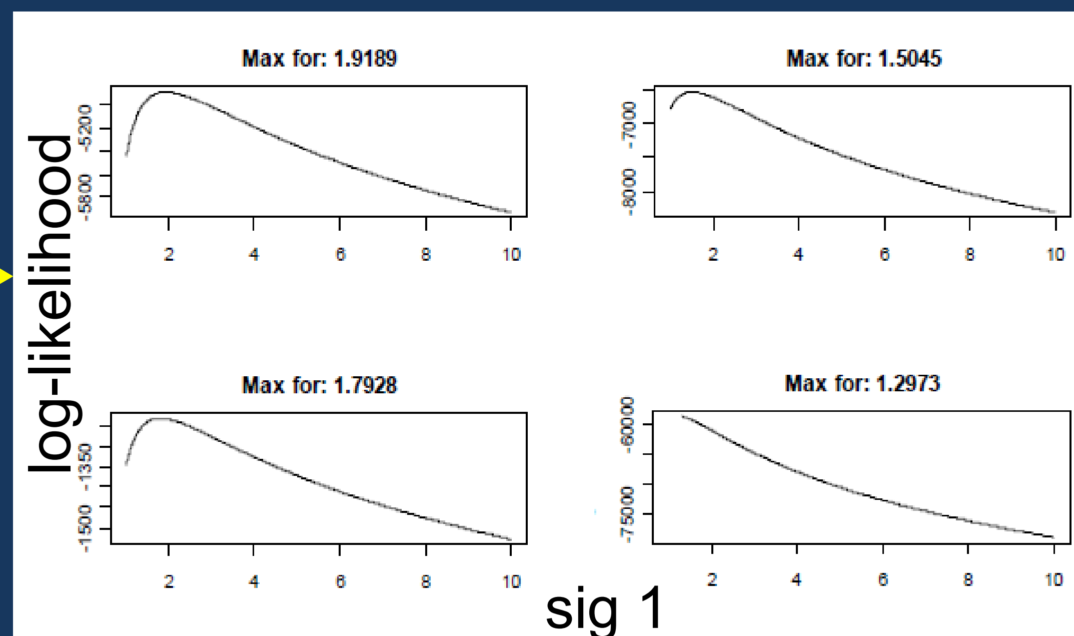


Values for Smoothing Parameters

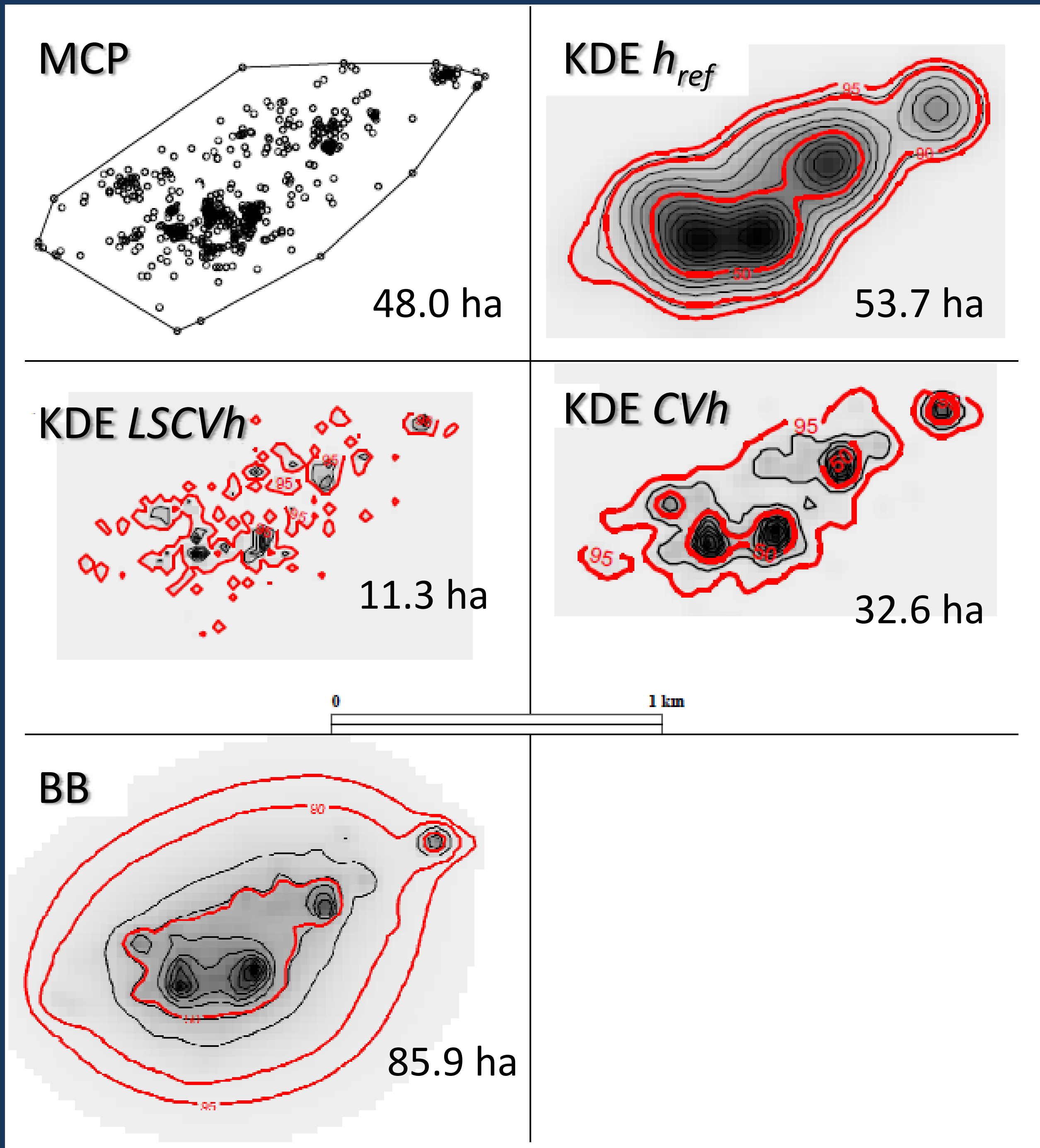
- **Datasets of the sows were shown to have multiple centers of activity of which the mean integrated square error (LSCV*h*) could not be minimized.**

- KDE smoothing parameter, *h*
  - *h*Ref – 35.54 (SD=27.61)
  - LSCV*h* – 4.17 (SD=2.39)
  - CV*h* – 28.44
- Brownian Bridge
  - Telemetry error = 9.2 m
  - Mobility variance parameter = 1.625 (SD=0.29)





Salbosa/Lepczyk 2009



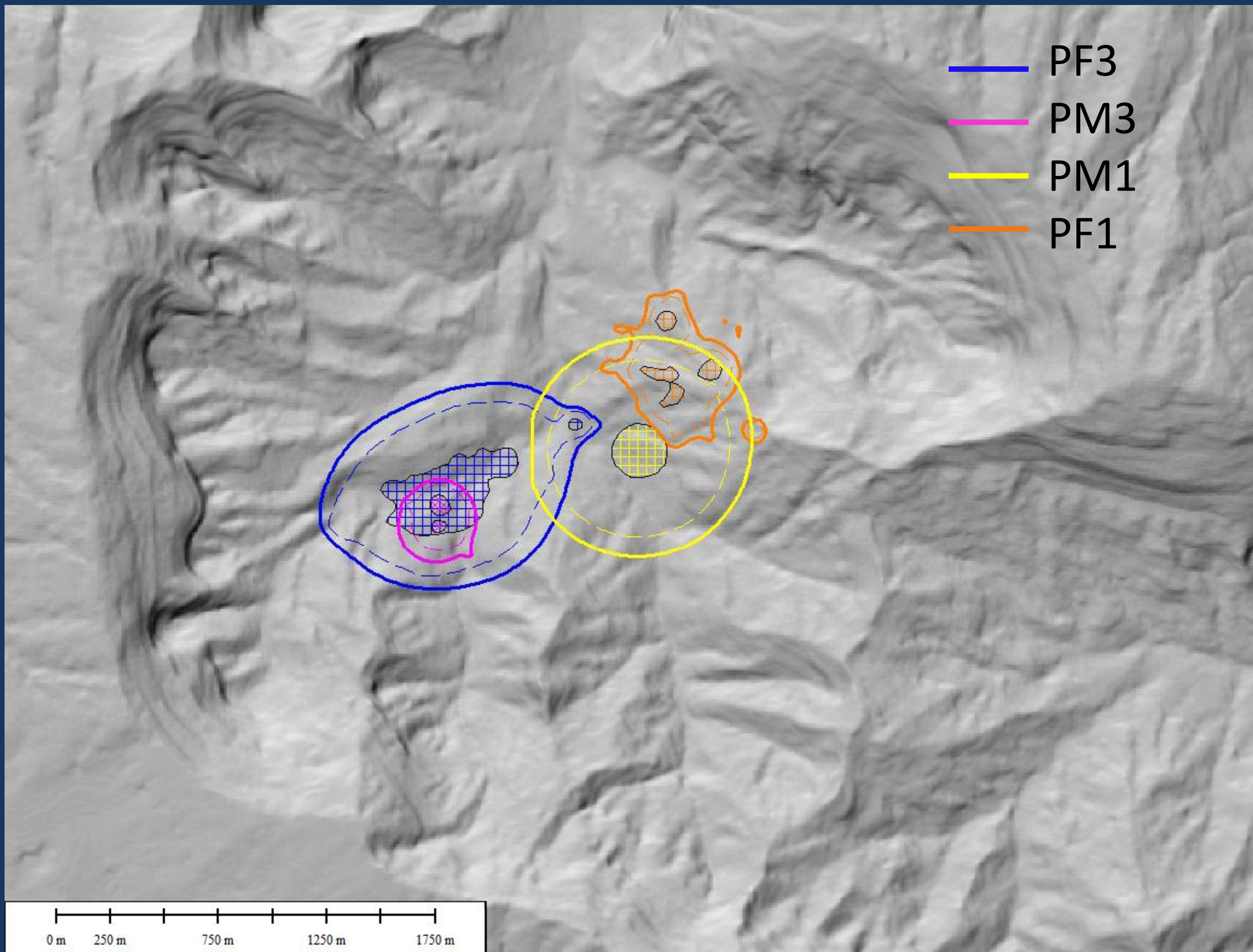
HR Estimates of mature sow using 5 different methods

- Labeled contours represent respective UD levels
- HR estimates shown in hectares at the 95% UD level

Conclusions

- *h*Ref based on average covariance tends to over smooth data
- LSCV ineffective when subjects have multiple centers of activity
- CV method provides conservative estimate of home range, which could have implications for species conservation or the creation of habitat buffer zones
- BB method appropriate when (1) habitat is heterogeneous, (2) data is collected in relatively short time intervals, (3) animals have multiple centers of activity, and (4) animals have terrain or mobility constraints to movement

Management Implications



Brownian Bridge HR estimates adhered to variable terrain constraints. Sows portrayed multiple centers of activity whereas boars had a single large resource center. All home ranges at the 50% UD level were mutually exclusive, with one exception here, shown in the pink, which is a smaller boar that may be an offspring.

HR Estimates based on the Brownian Bridge

- Subjects remained within a radius of 1.65 – 2 km
- HR estimates using the BB method averaged 68 ha
- Resource selection & behavioral studies to alter feral pig behaviors and draw animals away from fragile resource centers

Acknowledgements

- Thesis Committee Members:
  Dr. Christopher Lepczyk, Dr. David Duffy, & Dr. Gregory Bruland
- The Nature Conservancy Hawai‘i field programs on Maui, Molokai, and Kauai
- Native Hawaiian Science Engineering & Mentoring Program (NHSEMP)
- Kamehameha Schools, ‘Imi Na‘auao Program
- Strategic Environmental Research and Development Program (SERDP), U.S. DoD