Kauai Mongoose Standard Operating Procedures to Conduct an Island-wide Status Assessment and Early Detection Rapid Response

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1.0 Background

Mongooses were introduced to Oahu, Maui, and the Big Island during the 1880s. Fortunately, Kauai remained mongoose free when a planned introduction was aborted; however, there have been almost 350 reported sightings since 1968 and in 1976 a road-killed, lactating female was found on the island near Eleele. In 2012, two mongooses were captured in Lihue, Kauai, illustrating the need for better biosecurity. The numerous sightings and three confirmed individuals have led to the perception among many persons on Kauai and in Hawaii that mongoose are now established on Kauai. While the 2012 arrival of mongoose is troubling, there remains scant biological evidence that a population of mongoose occurs on Kauai. Therefore, it was necessary to resolve the discrepancy between the perception and the evidence.

The USFWS-Pacific Islands Fish and Wildlife Office (PIFWO) in coordination with the Kauai Invasive Species Committee (KISC) held a planning meeting from 10-12 August 2015 on the island of Kauai, Hawaii. The meeting was an intermediate step in the effort by PIFWO and KISC to assess the issue of mongoose on Kauai and begin the process of implementing a Kauai Mongoose Management Strategy. The first day of the mongoose meeting was comprised of presentations and a panel discussion and was attended by more than 60 federal, state, and non-governmental biologists that are active in conservation of species affected by mongoose in Hawaii, as well as international mongoose experts. Participation in the last two days was limited to five mongoose biologists and a five-member PIFWO and KISC mongoose planning team. Their objective was to develop draft standard operating procedures (SOPs) for addressing the issue of mongoose on Kauai.

2.0 Purpose

The purpose of these SOPs is threefold. First, they are designed to determine if an incipient population of mongoose exists on Kauai, i.e. a population status assessment. It is important to note that the SOPs are not intended to detect a single individual on the island. The premise underlying this assumes one mongoose or a few widely dispersed individuals pose little to no risk of establishing a population; however, an incipient population has a high probability of expanding to size that makes eradication expensive and very difficult. Furthermore, SOPs designed to detect single individuals would greatly exceed any potential funding resources and are unfeasible to implement in both costs and logistics. Secondly, these SOPs are designed to serve as an implementation strategy to eradicate an incipient population if detected. Finally, these SOPs will be used for Early Detection & Rapid Response (EDRR) for reported incursions if a future response is warranted. A mongoose detection during the assessment will initiate an Early Detection Rapid Response (EDRR) depending on specific criteria threshold (described in section 4.0).

For almost a decade, KISC has been the on-the-ground entity addressing the issue of mongoose interdiction on Kauai. The organization is uniquely positioned for this role because its mission emphasis is on early detection of, and rapid response to incipient invasive species. Additionally, KISC is an island-wide response entity, and able to work across jurisdictions with landowner permission. KISC will continue in this role and will implement these SOPs with the oversight of PIFWO and in coordination with Hawaii's Department of Land and Natural Resources, Division of Forestry and Wildlife (DOFAW).

3.0 Status Assessment

3.1 Scope

As noted above, it is not feasible to survey the entire island. Therefore the status assessment surveys are focused on areas where there is a reasonable probability of a mongoose reaching an area by being transported in cargo, escaping from captivity, or being intentionally released (Fig. 1, see below and Appendix A. for process used to define survey area). The likelihood of a mongoose establishing was also included as a factor in determining where to conduct surveys, with areas ranked based on the localized food resources and available habitat. In addition, to help prioritize and identify survey areas, it was determined that some locations could be excluded from the assessment surveys. Areas to be excluded are those where rigorous trapping or survey efforts have recently been conducted and areas of high human population density. The latter is based on the premise that if an incipient population of mongoose is already established it would have been detected by local residents, as evidenced in the Kauai Lagoons incursion.

3.1.1 Survey Areas

A. Navigable Roadways – any road sufficient to permit a vehicle capable of transporting cargo in which a mongoose could stowaway and that leads to a site where cargo would be offloaded.

B. High Risk Areas (HRAs) – areas where cargo capable of concealing and containing a mongoose is offloaded, including:
    i. Human habitation
    ii. Construction areas
    iii. Farms & ranches
    iv. Produce delivery areas (including grocery stores).

C. Establishment component – areas defined by A & B above will be ranked based on the attractiveness and suitability of the area. If resources are limited, then higher ranking areas will be prioritized (The below areas are ranked, high to low).

i. Areas with anthropogenic food resources (e.g., dumps/landfills)

ii. Intermediate forested, shrub, and wetlands

iii. Upper elevation forested lands

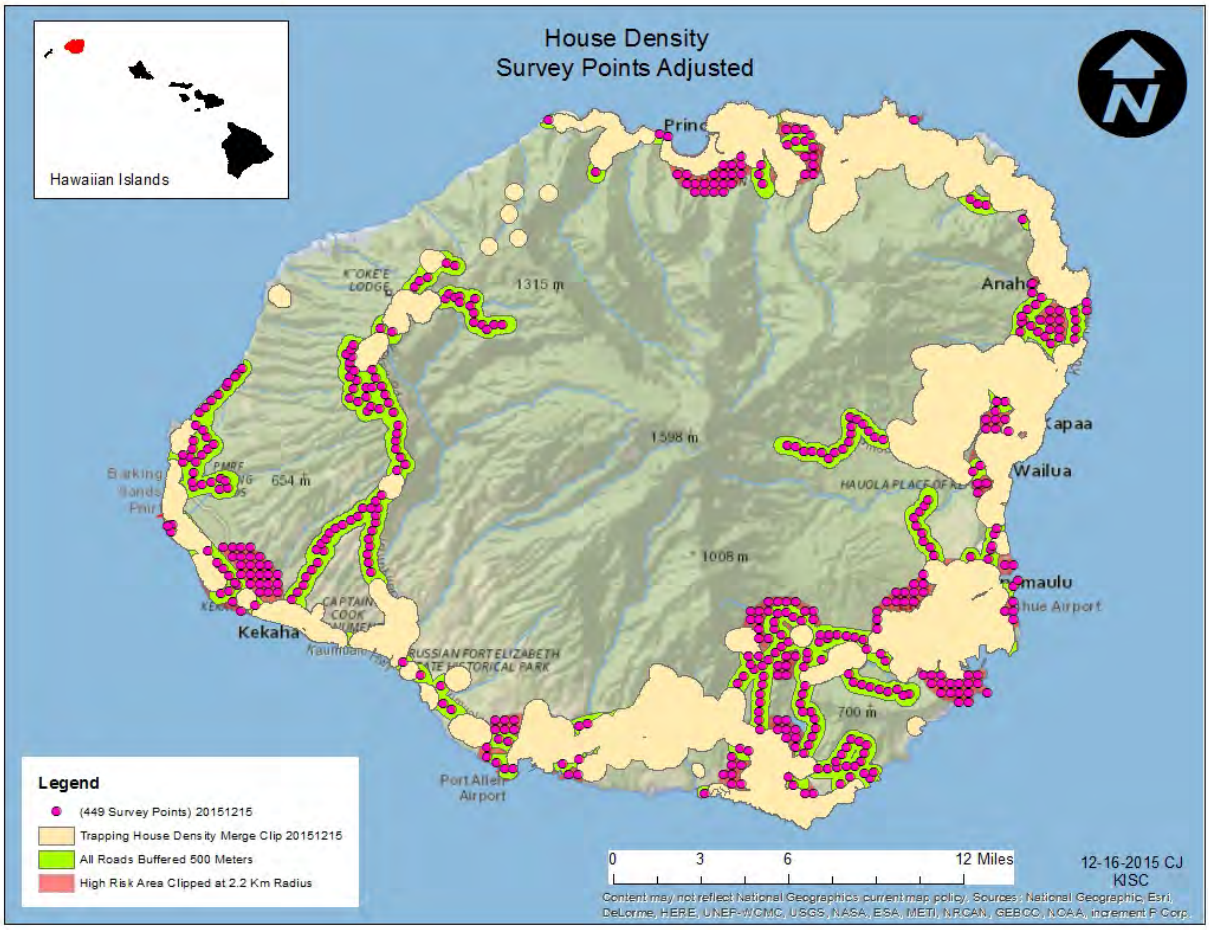


Figure 1. Mongoose status assessment survey area with more than 500 survey points. Areas with a housing density >25/km^2 and those that have been adequately surveyed since 2012 were excluded from the status assessment survey.

3.1.2 Exclusion areas

A. High Human Density – high human density was based on the clustering of human habitations.

i. GIS was used to identify areas of clustering (See Appendix A);

ii. Areas with housing density >25 / km^2 was designated as clustered and met the "high" density criteria. This density was a compromise between rigor and feasibility.

B. Current or Recent Predator Surveys/Management – locations where entities, such as KISC, NWR, USDA-WS, have conducted management or surveys using trapping or other detection techniques (e.g., cameras, tracking tunnels) for mongoose or other predators (e.g., feral cats.)

Locations where survey or management efforts were conducted prior to 2012 will not be excluded from the assessment.

3.1.3 Survey Tools & Techniques

Several tools to detect mongoose were discussed at the August 2015 meeting. These included tracking tunnels, traps, dogs, chew cards, and cameras. Dogs were deemed too expensive, showed mixed results on Oahu, and not applicable to our current purposes. Chew cards have potential, but testing would be required before they could be deployed on Kauai. Cameras do not provide sufficient additional information relative to tracking tunnels to warrant the significantly higher per unit price. For the assessment surveys, capture is not necessary, so traps were omitted from consideration, primarily because they are labor intensive. Live traps require checking every 24 hours. Tracking tunnels were deemed the best tool for the assessment and will be the primary method deployed. Two KISC staff will attend training at the USDA-National Wildlife Research Center in Hilo, HI to improve their ability to differentiate mongoose tracks from other species of mammals. If on-the-ground conditions dictate the use of a tool other than tracking tunnels, field staff have the option to deploy an alternative, such as cameras. A single type of standardized bait (e.g., fish paste) will be used at all stations; however, alternative baits (e.g., coconut) will remain as backups, as needed.

While mongoose detection dogs are not included in the current SOPs, they remain a viable option for some components of mongoose management on Kauai, such as interdiction at ports. Additionally, if mongoose detection dogs demonstrate utility in the future and long-term funding becomes available, their inclusion in the overall mongoose management strategy will be considered.

3.1.4 Spatial Configuration

Tracking tunnels will be deployed in two configurations. They will be placed on transects along designated roadways and in a grid pattern at HRAs. A 500 m inter-station interval will be used on both roadway transect and grids. Station coordinates will be determined using GIS and staff will use GPS to locate station position in the field. For road transects, stations will be placed off the road as much as

practicable and necessary to prevent tampering and vandalism, while staying within the road easement. For HRAs, field staff will attempt to adhere to the pre-determined GIS coordinates; however, it is recognized that on-the-ground conditions may require modification of station position. If a position adjust >5m is necessary, field staff will record the new location using GPS so GIS files can be updated.

Grids overlaid HRAs will normally use either a 1.5 km or 2.0 km buffer, with the HRA position in the center (Fig. 2); however, on the ground conditions may require adjustments in these parameters. For example, terrain features (e.g., coastlines or cliffs) may require truncating the buffer distance on a particular side, but every effort will be made to maintain a minimum 1 km buffer.

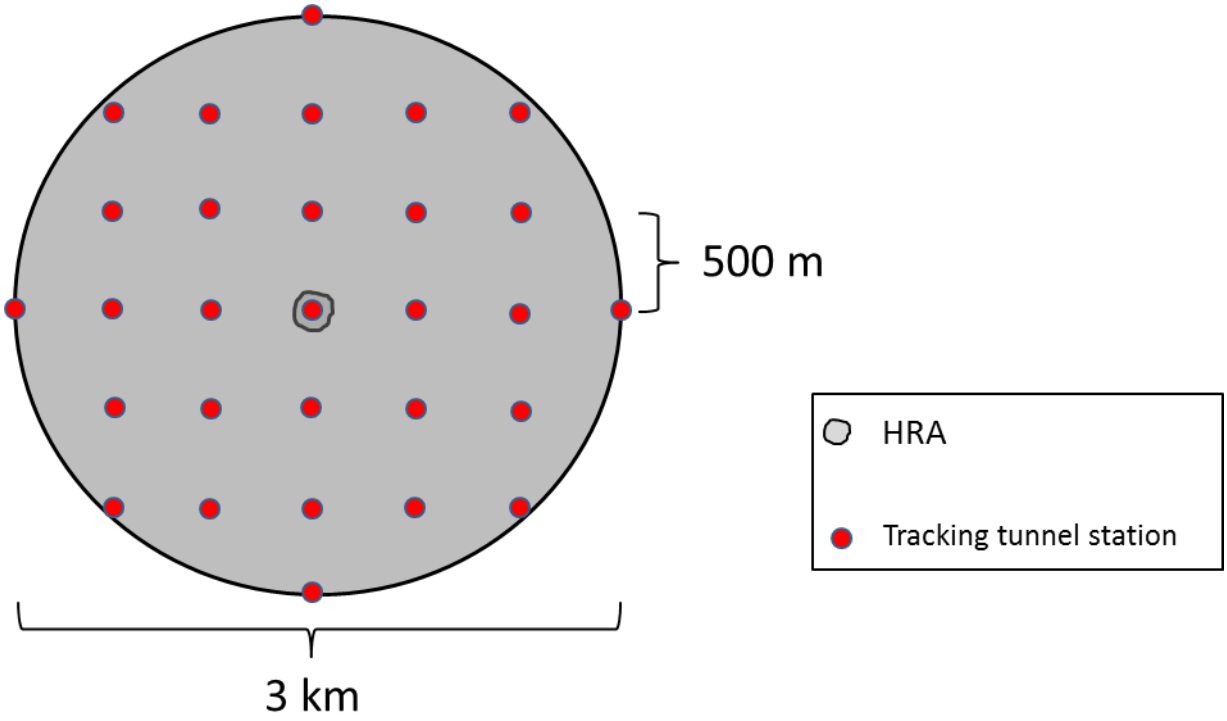


Figure 2. Grid overlay of a High Risk Area (HRA) with a 1.5 km buffer.

3.1.5 Temporal Scale

Surveys in a given area will be conducted for one consecutive week. Tracking tunnels will be checked at the end of the survey period when they are pulled from the field (See Data Collection Forms Appendix B). In an effort to determine effort and personnel time required to conduct the assessment survey, KISC staff deployed tracking tunnels at multiple locations across Kauai. Tunnels were checked at days 4, 5, 7, 10 15, and 30. Track cards remained readable up to day 10. If a track card at a station is unreadable due to any reason (e.g., theft or disturbance of tunnel, or too many prints) another tunnel may be placed for an

additional week to compensate for the absence of data. The survey area may be divided with portions surveyed sequentially. Surveys will be repeated in a given area every quarter (i.e., four times in a year). Surveys will be conducted for one year. Extending surveys beyond one year transitions to monitoring, which was deemed inappropriate.

3.1.6 Mongoose Detection

A positive signal at a tracking tunnel would trigger a Rapid Response situation (see below); however, the assessment would continue as scheduled. KISC has sufficient field crew to mobilize a rapid response allowing the Island-wide survey crew to continue in order to maintain data collection consistency. Additionally, detections on State land will allow DOFAW to deploy additional response technicians from the Kauai Branch Office. Evidence constituting a confirmed detection includes a photo, tracks, hair, or any part of a mongoose.

4.0 Mongoose Response Protocols

4.1 Scope

A confirmed detection of a mongoose during the assessment survey or reported sightings that meet the response threshold (see below) would trigger a rapid response. In the event of a confirmed detection during the status assessment, KISC will communicate and coordinate the response with PIFWO & DOFAW. The capture of a mongoose during the response would initiate further communication and coordination with the PIFWO and DOFAW to determine what level of management response is warranted. It is essential that inter-organizational coordination does not delay the response. KISC will maintain all response components (e.g., materials, land owner permissions, personnel) necessary to implement a response in a timely manner.

4.1.1 Response Tools & Techniques

Three types of tools will be used during responses. Kill and live traps were evaluated and kill traps will be the primary tool deployed on the grid. This decision was based on personnel resources, with live traps requiring substantially more labor than kill traps. Various trap types were discussed (e.g., Conibear, the Japanese tube trap). The DOC 250 traps were considered the best choice at this time; however other traps will be considered as new models become available. To minimize non–target captures, kill traps must be

housed in a hard-side container (e.g., Fig.3); however, if it appears capture success is being reduced by

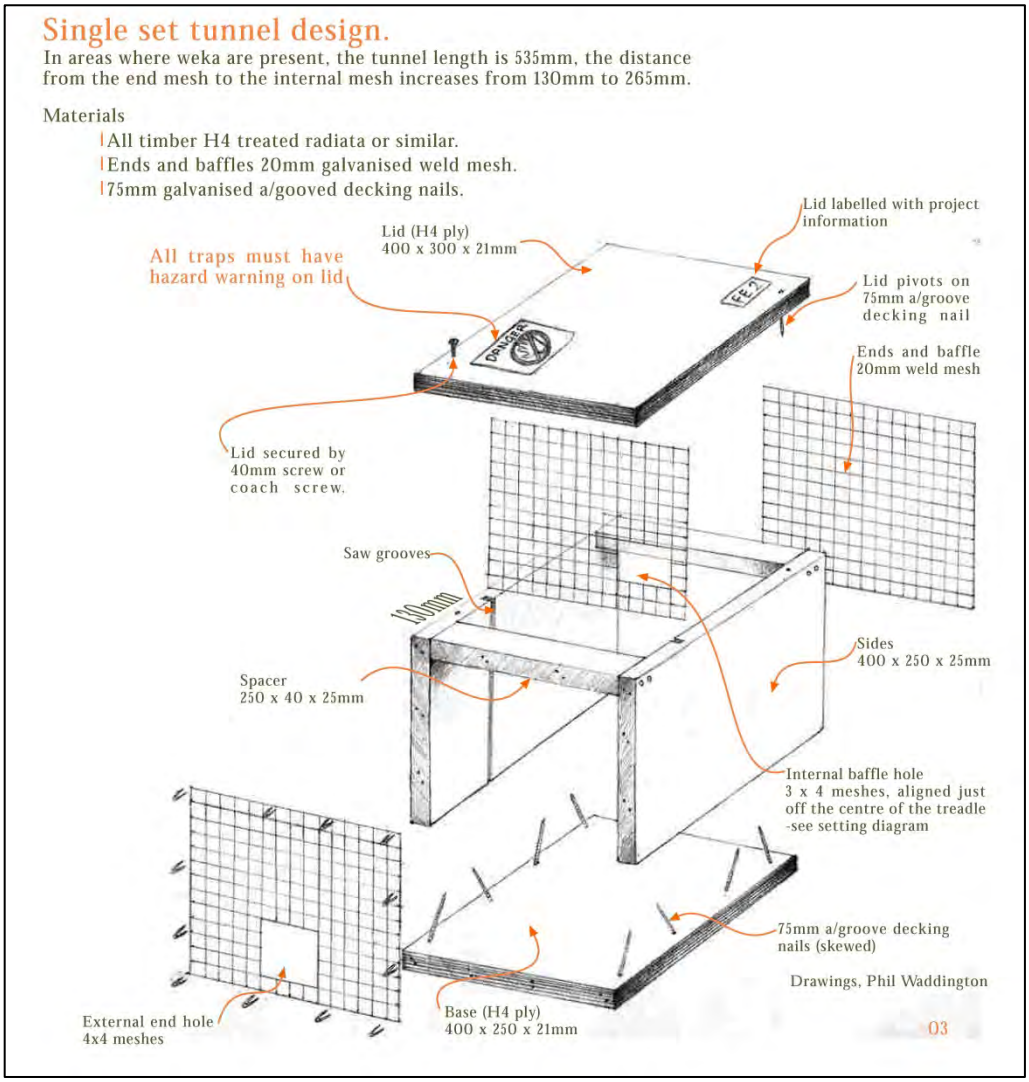


Figure 3. Housing for DOC250 traps. This configuration is used on Oahu for mongoose management (Tyler Bogardus, Oahu Army Natural Resources Program, pers. comm., 2015) http://www.predatortraps.com/downloads/doc%20250%20setting%20instructions.pdf

the trap housing then bycatch of non-target species may be de-emphasized to prioritize the capture of a mongoose.

In situations where kill traps are unacceptable, due either to concerns with threatened species or public perception, other tools will be deployed. Live traps (Tomahawk) are the preferred alternative, but when staffing is insufficient, tracking tunnel or cameras will be deployed. A confirmed detection at a tracking tunnel or camera would trigger replacing these with traps. Bait stations with the toxicant diphacinone (i.e.,

Ramik bars) were considered, but because the current bait formulation is known to be unpalatable to mongooses (Robert Sugihara, National Wildlife Research Center (NWRC), pers. comm., 2015) this tool was not incorporated in to these SOPs; however, as new bait formulations or pesticides become available the use of toxicants will be reconsidered.

Three bait types will be used in traps: fish (any species of fish, not canned tuna), beef strip, and coconut (chunks, not toasted). These are presented in order of preference. One bait type will be used each week, with all bait types cycled through during the course of the trapping. If there is a need for a longer lasting bait (e.g., weeks to months), the project will investigate the use of salt pork and dried squid, which have proven effective in Japan for 7 days (pork) to 1-2 months (squid). Baits for tunnels should be the same as used in assessment.

4.1.2 Spatial Configuration

As with the HRAs, a grid will be overlaid on the location of the detection point. In a response situation, the grid will be larger with the buffer distance extending 2 km form the detection point. A 500 m station spacing is optimal, but as with HRAs, on-the-ground conditions will dictate the exact placement of traps. It is understood that features such as roads, and habitations will alter exact placement of traps/detection devices and terrain features (e.g., narrow steep valley) may alter the shape of the grid. Additionally, if a waterbody or cliff is within the 2 km buffer square, shape of the grid will be altered and side opposite the waterbody/cliff may be expanded. In the course of responding to the initial detection, if a new detection within the grid would trigger the re-establishment of another trapping grid.

4.1.3 Temporal Scale

For a confirmed detection, trapping will be conducted for a period of 2-4 weeks. If after 4 weeks no mongoose capture occurs, but evidence warrants continued effort (e.g., sighting), tracking stations would replace traps at all stations, with the survey continuing a maximum of 3 months following the above procedures. Confirmed evidence of a mongoose without a capture may extend the response period. A capture of a mongoose during the response period would restart the time period and may trigger further management efforts (see Scope above). For a reported sighting, response efforts would cease after 4 weeks unless there was a confirmed detection, which would initiate the above procedures.

A. Kill traps will be checked twice per week (e.g., placed Monday, checked & re-baited Thursday), with the process repeated for the duration of the response; however, if staffing becomes limited then trap check frequency may be reduced to one time per week.
B. Live traps must be checked daily (i.e., every 24 hours) and baited as needed.
C. Live traps will be opened Monday AM and closed Friday PM.
D. Tracking tunnel procedures would follow those for the assessment survey.

5.0 Response Threshold

As mentioned above, there have been more than 300 reported sightings of mongoose on Kauai. The vast majority of these are considered non-credible. For a variety of reasons, including the need to conserve resources, it is important minimize responses to erroneous sightings. The staffs of PIFWO and KISC have been working on a method to distinguish credible from non-credible sightings using the report intake form. These efforts have not resulted in a reliable method of identifying a credible sighting; however, in the process of attempting to identify credible sightings, it was determined that patterns of multiple sightings can be used to identify potential credible sightings. This method will be used to create a "response threshold." The threshold that will initiate a response to future reported mongoose sightings is three sightings within a two-week period that are enclosed inside a circle of a 0.5 km radius. These parameters were derived from the spatial dynamics of mongoose on both Hawaii Island and on Amami Island, Japan during an eradication campaign as well as the sighting frequency of the mongoose at Kauai Lagoons in 2012.

6.0 Summary

These SOPs are designed to be adaptive, such that as new information and methods arise, the procedures can be modified. Modifications to the SOPs will be a result of coordination between PIFWO and KISC, in conjunction with partners such as DOFAW and mongoose biologists.

Finally, these SOPs are just one part of an overall management strategy to ensure Kauai remains mongoose free. It is essential that the status assessment, and any management response, is followed by a strengthening of biosecurity procedures to minimize the risk of transporting mongooses to Kauai from elsewhere in Hawaii.

7.0 Acknowledgements

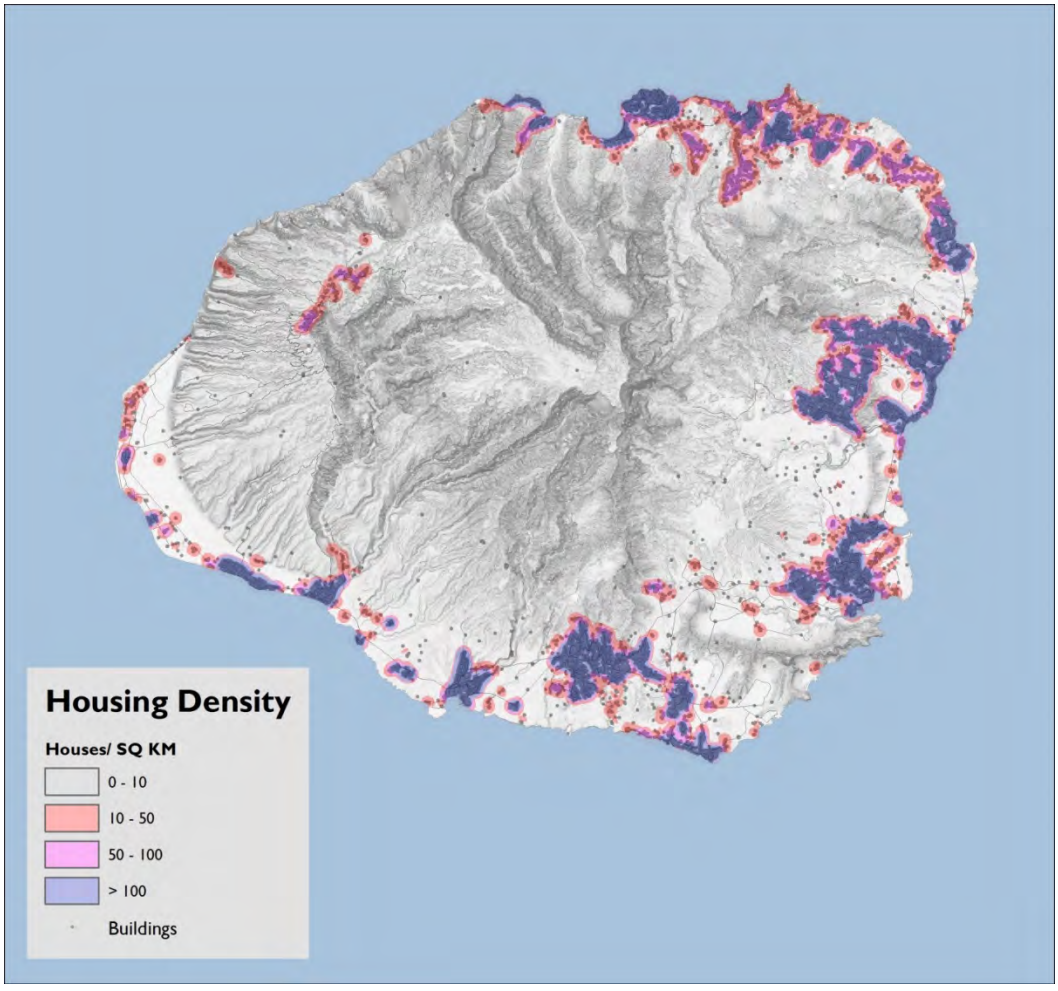
We would like to thank Earl Campbell (PIFWO) for recognizing the importance of this issue and supporting the need to re-assess the status of mongoose on Kauai. Adam Griesemer (PIFWO) provided insightful input during the SOP development at the August meetings and Cleve Javier (KISC) was instrumental in the development of the maps. The efforts of Raymond Kahaunaele and Tiffani Keanini (KISC) were key to making the August meetings a success. Christine Ogura helped with meeting facilitation. Finally, we want to thank Pat Gmelin (KISC) for his efforts on all stages of the development of these SOPs, but also for years of dedication to keeping Kauai mongoose free in partnership with Thomas Kaiakapu (DOFAW) and Bill Bukowski (USDA-Wildlife Services).

8.0 Appendices

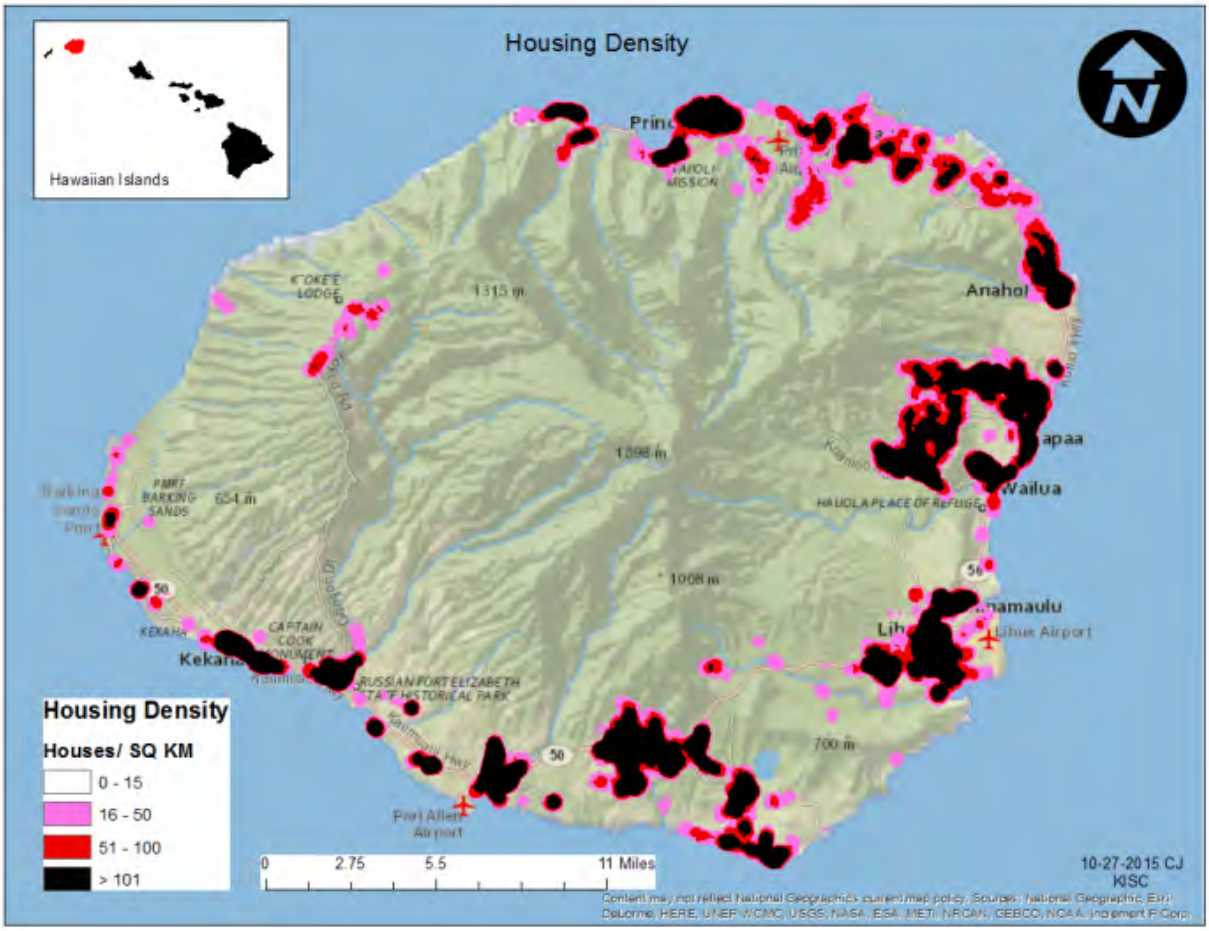
Appendix A – Mapping Development Process

Step 1. *Determining exclusion areas based on human population density* – Map 1a was developed using a point density map derived from the Kauai County Housing GIS layer, resulting in housing densities at 0-10, 10-50, 50-100 and >100 houses / km^2. Each point represents a taxable structure. Kernel density was also tried as a method but the smoothing averages created too large an area reducing the survey footprint to the point where survey points were excluded in areas that would otherwise fit the distance requirement from housing

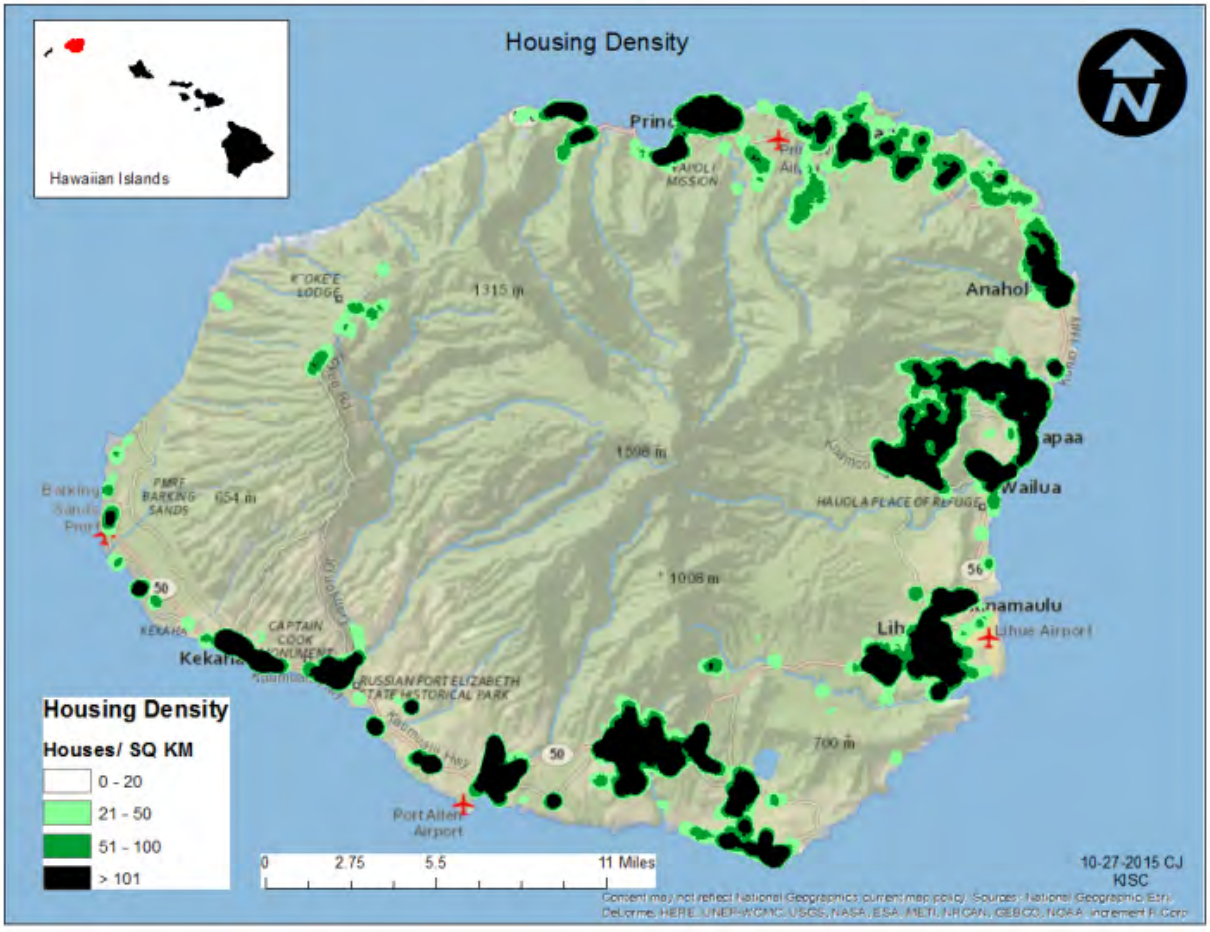
Using the point density ranges from Map1a, new density ranges were applied resulting in Maps 1b, 1c, and 1d, which show densities of 0-15, 0-20, and 0-25 houses / km^2. Note that the differences in relation to the overall survey are slight allowing use of a conservative buffer of 1-25 houses/km^2.



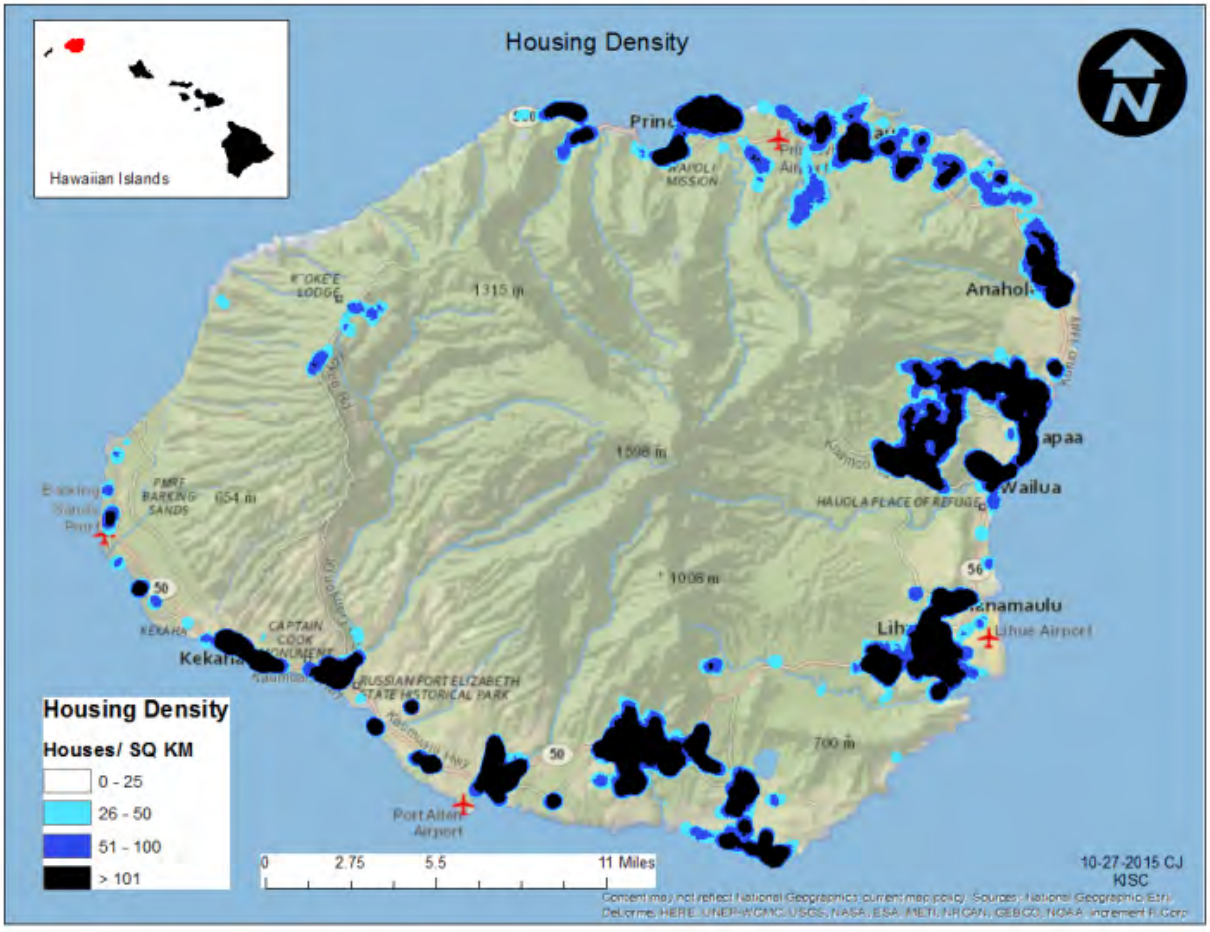
Map 1a.



Map 1b - Housing Density 0-15/km sq.

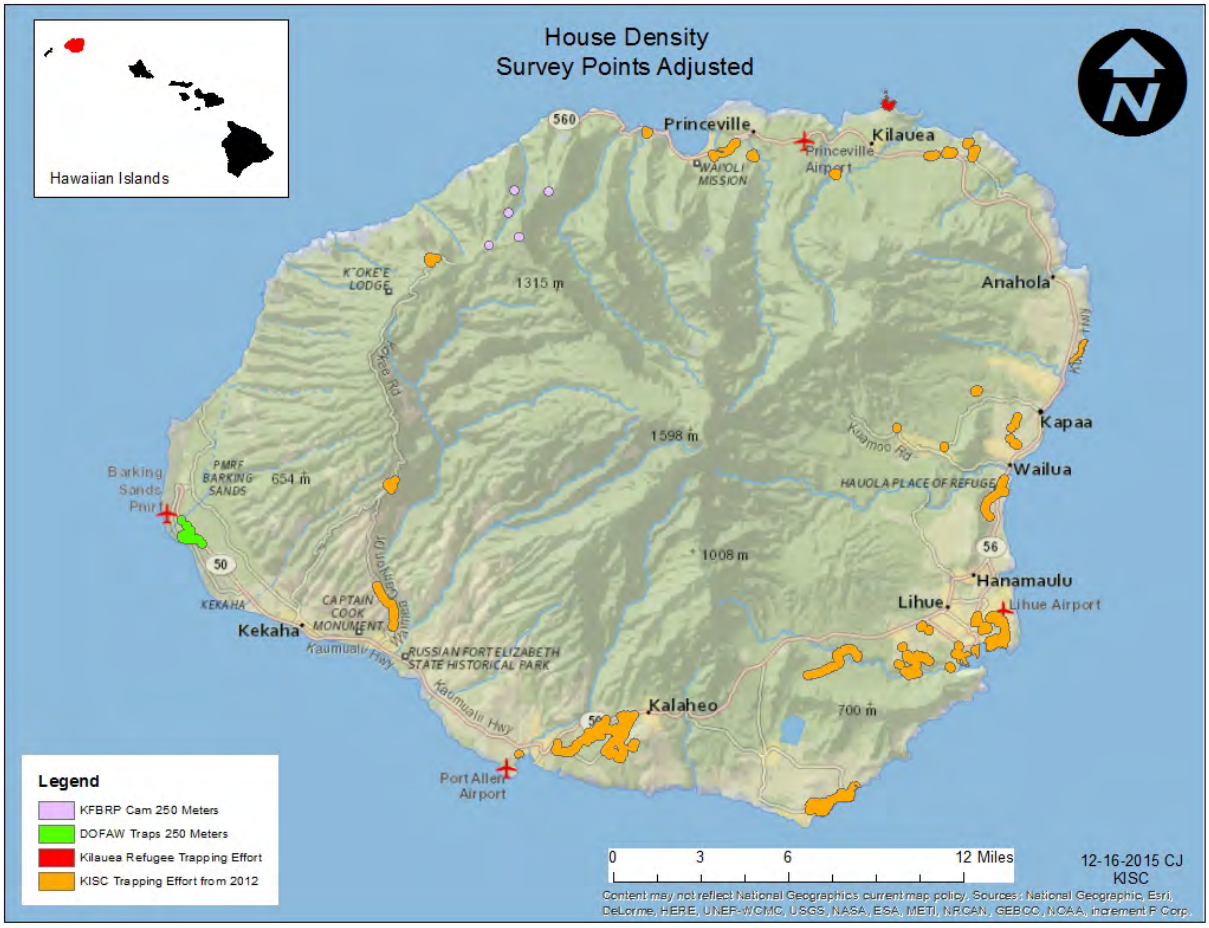


Map 1c - Housing Density 0-20/km sq.



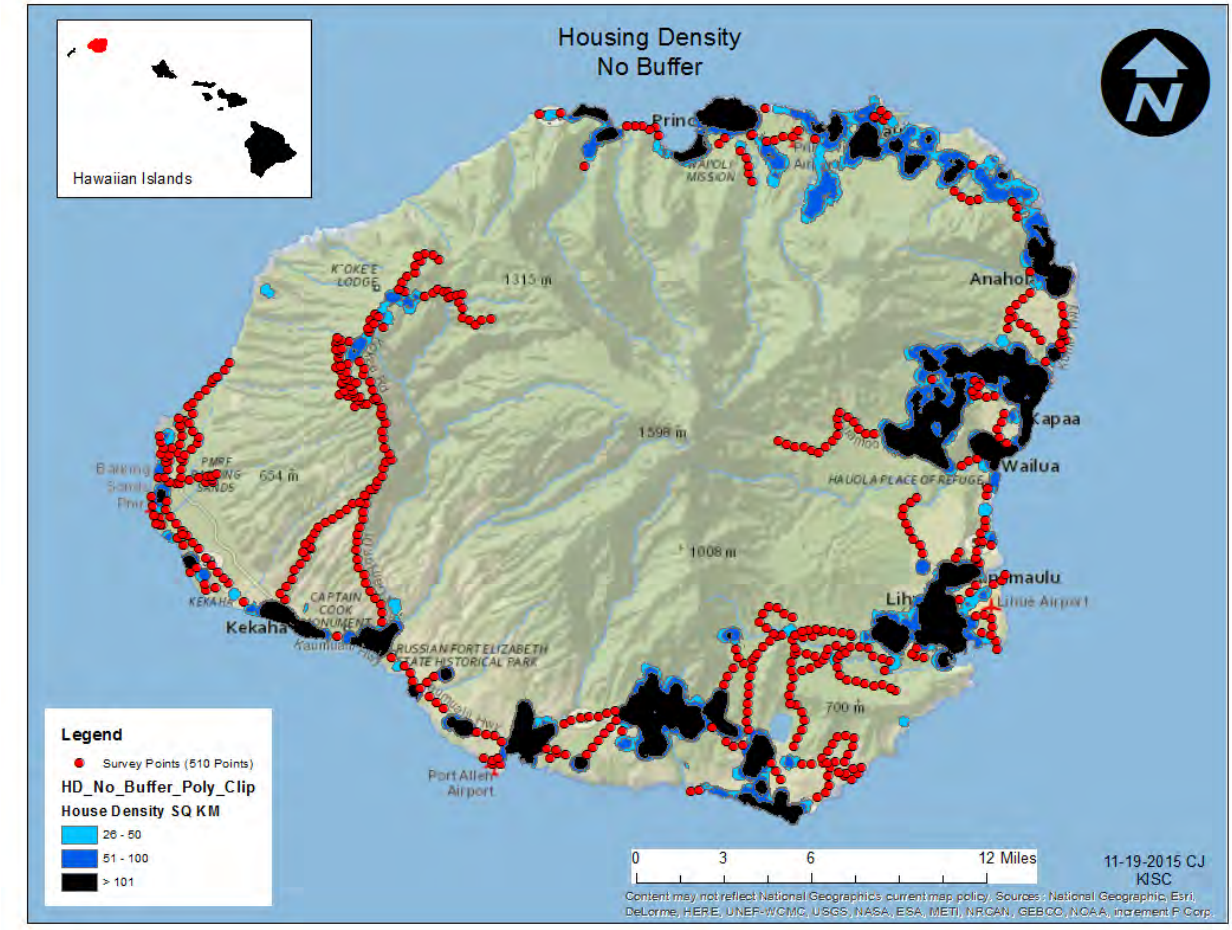
Map 1d - Housing density 0-25/km sq.

Step 2. *Determining exclusion areas based on previous trapping or survey efforts* –Map 2a shows areas where rigorous trapping or survey efforts have been conducted since 2012. Areas shown have a 500 meter buffer around actual area where detection tools were deployed.

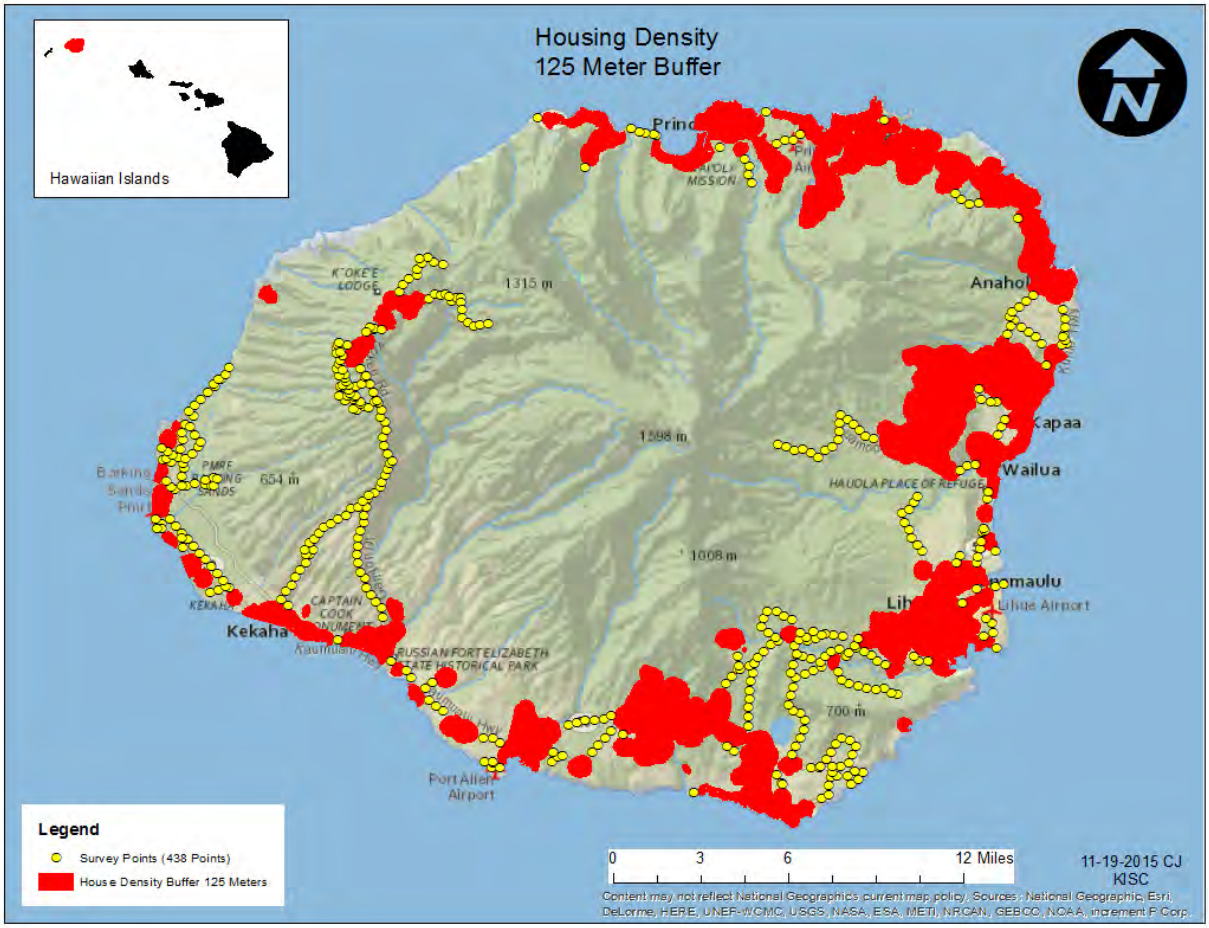


Map 2. Exclusion areas based on past trapping and survey efforts.

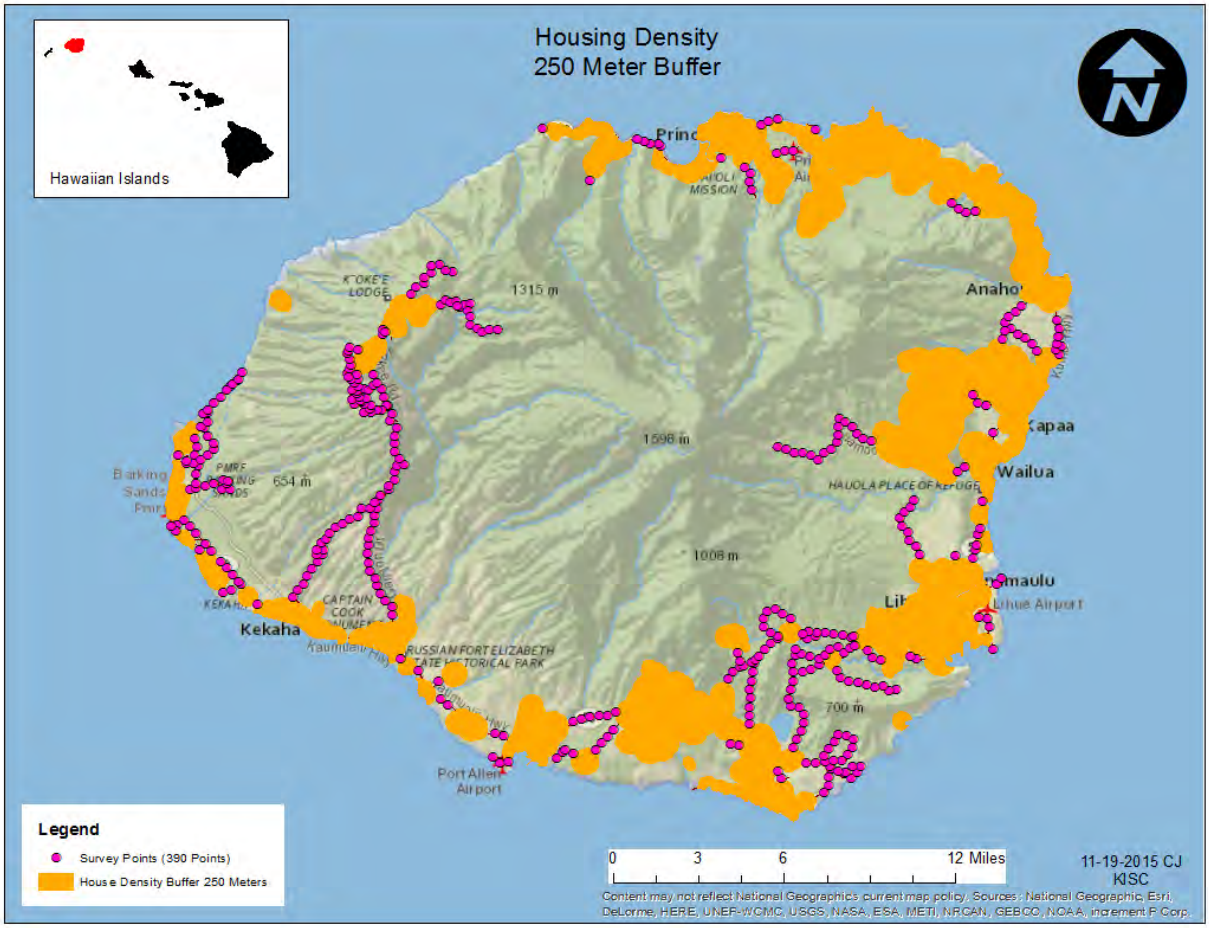
Step 3. *Examining relationship between tracking tunnel locations and housing densities* – Maps 3a, 3b, and 3c illustrate



Map 3a. No 250m housing density buffer tracking tunnel total = 640

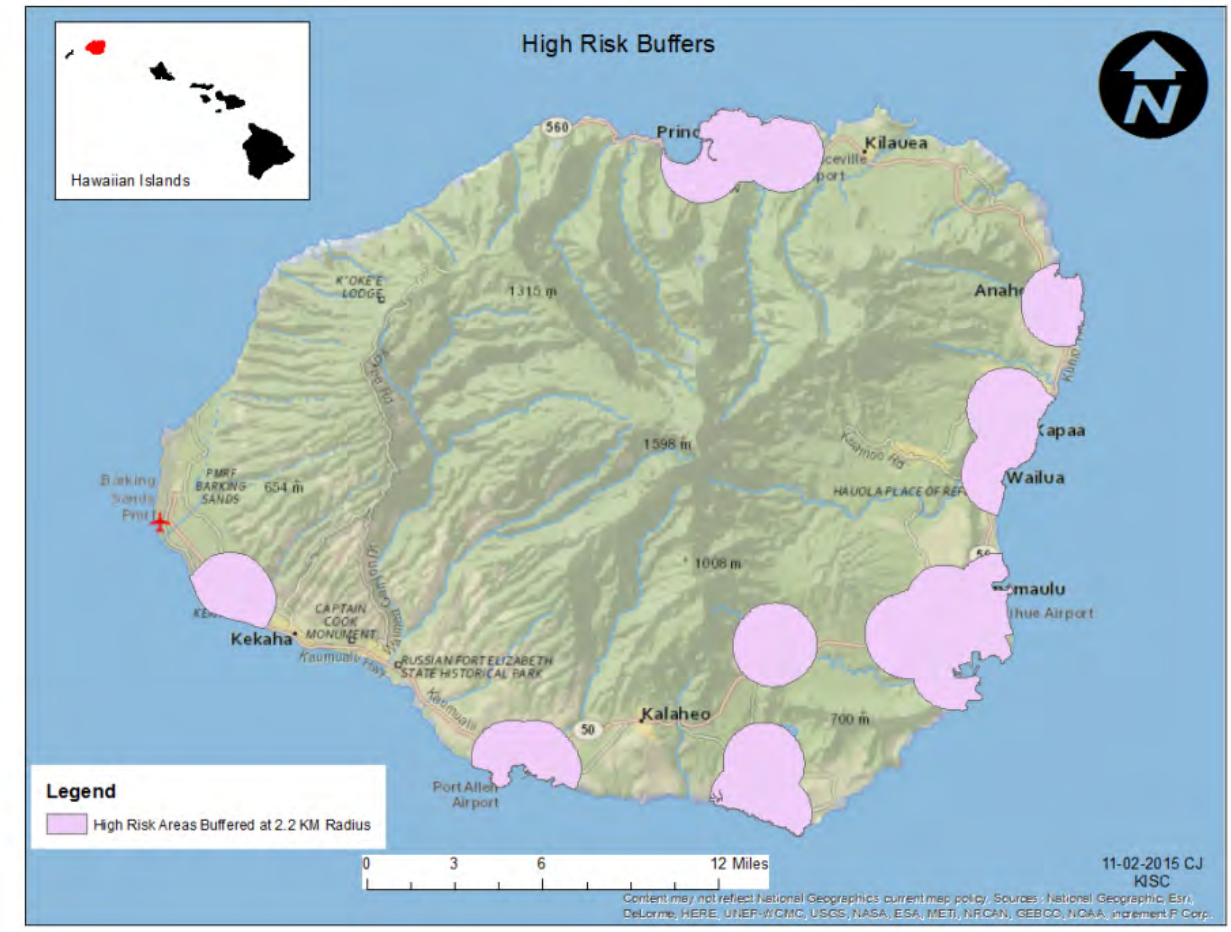


Map 3b. 125 m buffer tracking tunnel total = 564



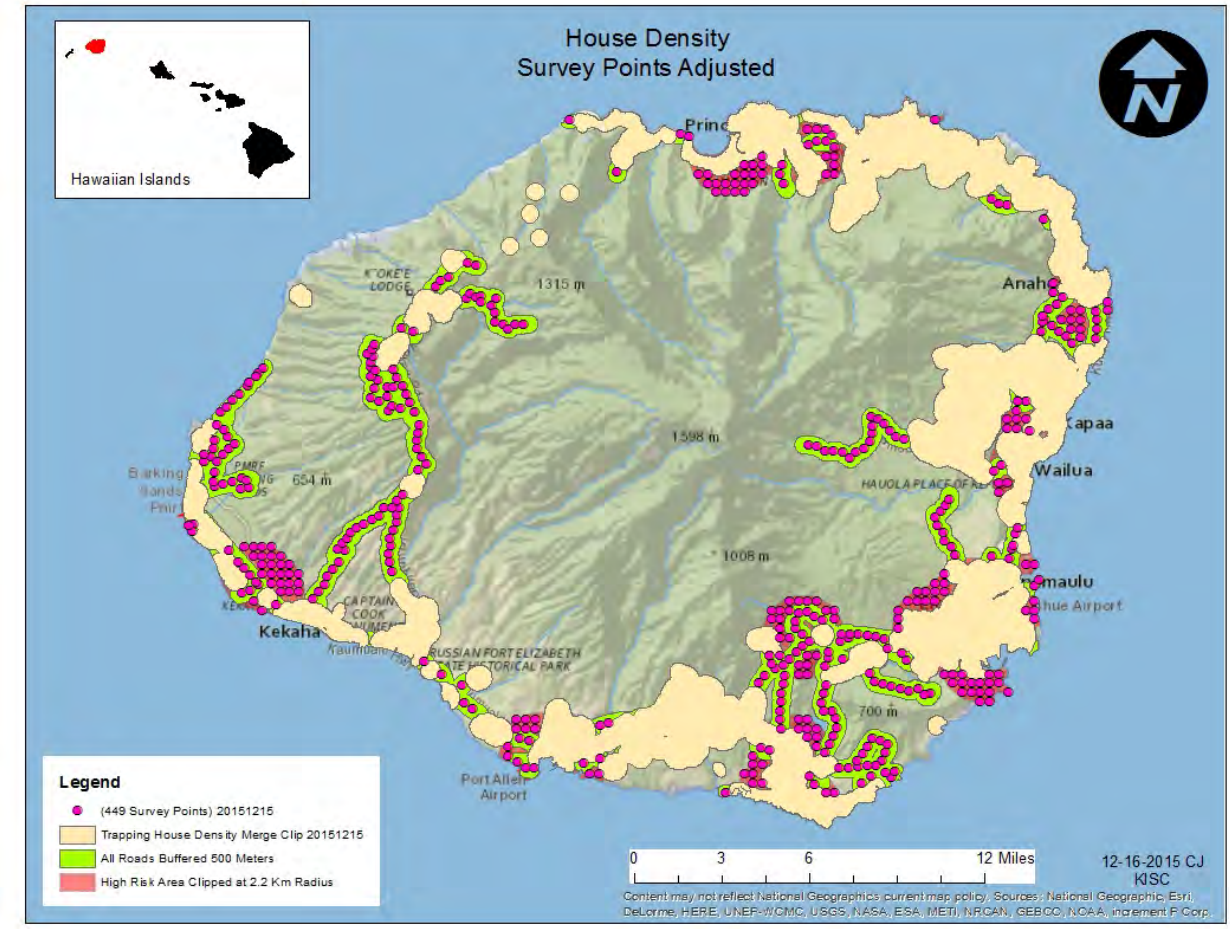
Map 3c. 250 m buffer tracking tunnel total = 510

Step 4. *Determining high risk areas (HRAs)* – Using local knowledge KISC staff compiled locations of HRAs focusing on large agricultural operations, recent large construction projects, "Big Box" stores and large grocery stores. These areas were buffered according to the rapid response criteria and are depicted below in Map 4.



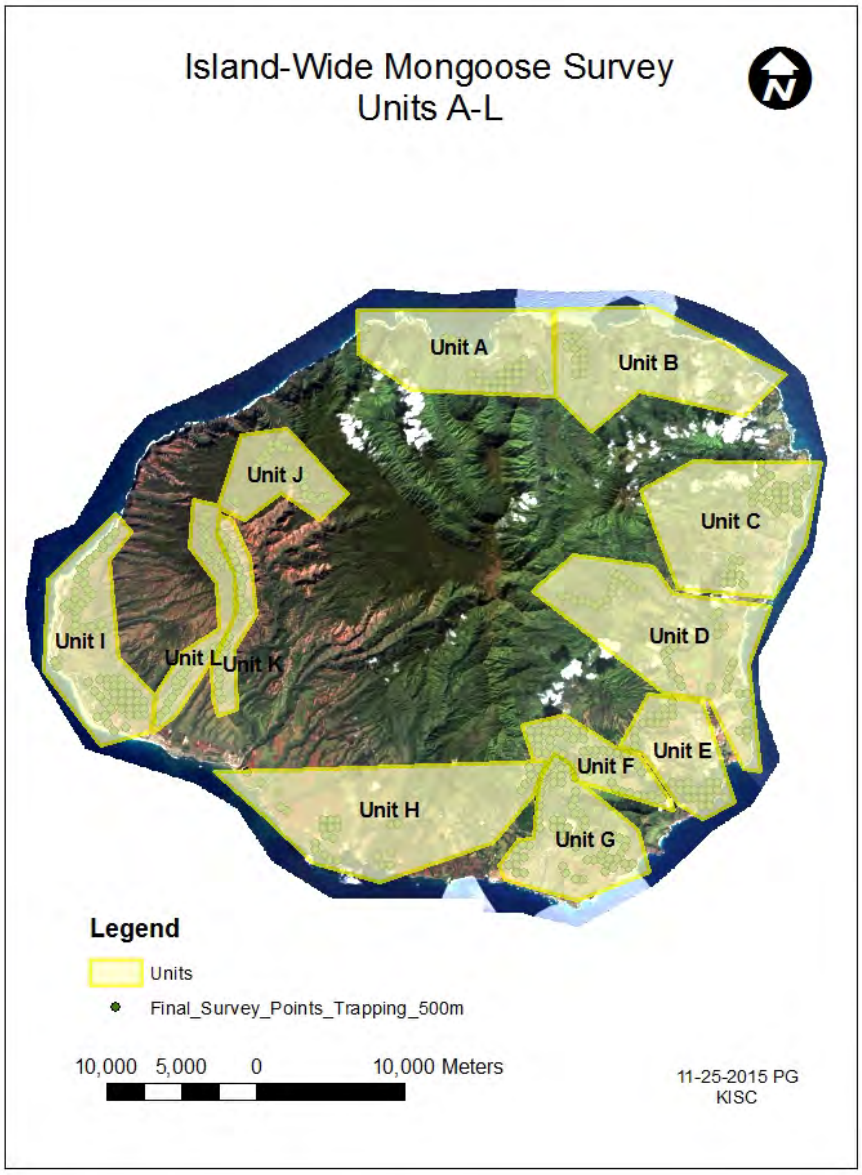
Map 4. High risk areas buffered at 2.2 km radius.

Step 5. *Overlaying Exclusion and High Risk Areas on map of tracking tunnels on prescribed roads* – To create Map 5, a base map of tracking tunnels set on a 500 m linear or polygon grid was created. Overlaid on this were the two exclusion area maps, the human population density exclusion map ≥25 houses / km^2 of buffered and the previous trapping and survey effort map, both buffered at 250 meters. Finally, the High Risk Area map, buffered at 2.2 km was overlaid.



Map 5. Exclusion areas buffered at 250 m for housing and 500 meters for trapping and High Risk Areas buffered at 2.2 km overlaid over transects and grids of tracking tunnel stations spaced at 500 m intervals.

Step 6. *Dividing assessment area into management units.*



Map 6. Based on five days of trial runs, the KISC survey crew delineated 12 survey sections to represent one day of tunnel placements.

Unit Tracking Tunnel Data Sheet

Weather:_____ **Date Set:**_____**Observer(s):**_____
Unit:_____ **Date Checked:**_____ **Observer(s):** _____

Station No.	**Access**	**Side of Road***	**Bait Type**	**Species†**	**Photo (Y/N)**	**Comments**
1						
2						
3						
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35						
36						
37						
38						
39						
Total						

* - N, S, E, W

† - B-bird, C-cat, L-lizard, M-mongoose, R-rat or mouse, N-no sign