Geographic Information Systems (GIS) as a recreation management tool: monitoring human impacts at Fossil Creek, Arizona

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Professional paper submitted in partial fulfillment of the requirements of the degree of Master of Forestry

Northern Arizona University

December 2012

Preface:

This professional paper is written in a manuscript format to be submitted to the Journal of Parks and Recreation Administration with Dr. Martha Lee as a co-author.

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Executive Summary

Using GIS for monitoring and evaluating amenities has been done in the past on large scales, such as county or wilderness-wide. However, there are many useful applications for GIS for the management of smaller areas. Geo-spatial variables, such as distance and vegetation cover, can be measured with little to no cost to the land manager. Our objective is to demonstrate the applicability of using Geographic Information Systems (GIS) as a monitoring tool for recreation managers by using Fossil Creek as an example management area.

Fossil Creek is located in the Coconino and Tonto National Forests approximately 100 miles north of Phoenix, Arizona. The creek emerges from Fossil Springs and is about 17 miles long and was designated a Wild and Scenic River in March 2009. According to the Coconino National Forest website, over 1,000 people visit Fossil Creek every weekend during the popular summer months. So many people recreating in one area stresses the unique ecosystem and leads to degradation of the adjacent land, especially when there is a lack of adherence to the rules of human waste disposal.

Evidence points of human waste were collected between March and October of 2009 for seven sites. Locations of porta-potties and informational signs were also collected. The following relationships were examined though the use of GIS and the chi squared test to judge if there was a relationship with the amount of human waste evidence within Fossil Creek: distance from porta potties, distance from informational signs, and vegetation type where evidence is found.

The main factor that seems to have a relationship to human waste evidence is the porta potty distance, with a unanimous significant chi squared value across all sites. Informational

sign distance has significance for the Waterfall, Tonto, and Sally May sites. Vegetation type has significance for Homestead, Sally May, and Old Corral sites.

These results should not be interpreted as a general relationship for all recreation sites and porta potties since the purpose of this evaluation was to demonstrate the possible applications of GIS as a recreation management tool. Evaluating potential relationships between non-use of mitigation management tools and geographic placement within a park, however, could help managers locate their mitigation tools to maximize their effectiveness. Land managers face a range of difficult decisions when focusing on influencing visitor behaviors. Many of these decisions have to be made on intuition and experience with very little guidance on the monitoring objectives. Utilizing GIS to measure and monitor geo-spatial variables can aid managers and be a useful tool in extrapolating visitor management activities.

Introduction

Parks and recreation managers rely on many tools to monitor and evaluate amenities provided on their lands. One of the relatively recent tools is Geographic Information Systems, or more commonly abbreviated as GIS. A geo-spatially based computer program, GIS allows managers to inventory, monitor, analyze, plan, and communicate efficiently while saving time and resources.

While GIS can save time and effort, there are still some weaknesses that must be kept in mind when developing a GIS-based management plan. The United States Department of Agriculture published a guide on GIS applications to wilderness management (Landres et al. 2001), emphasizing the strengths and weaknesses of using GIS for wilderness management. The weaknesses they outlined were poor planning, poor training, poor documentation, data compilation is too involved and costly, overemphasis on technology, and unrealistic expectations. The first three weaknesses can be solved with adequate training and preparation. As long as a manager is comfortable and learning to be familiar with using GIS, there should be few problems with adopting it as a management tool. GIS data compilation that is too involved and costly would be a drawback if the manager first did not have access to GIS. A less expensive geo-spatial program can be used instead of GIS, such as Google Earth, if the cost of acquiring the GIS software is too expensive. Overemphasis on technology is an issue mostly confined to the debated ethics of wilderness management (Borrie 2000) and, as long as managers can make realistic GIS goals, unrealistic expectations can be limited.

In spite of the weaknesses of using GIS, land managers have used this technological tool for many monitoring and data sharing applications. GIS mapping has been used to document locations of archeological sites around the world, providing an easy way for managers to organize, share, and present data (Rowland & Connolly 2002). Another GIS recreation project in New Zealand focused on using GIS to map visitor perceptions of wilderness quality by combining surveys and GIS in order to understand the spatial link to visitor perceptions (Kliskey & Kearsley 1993). GIS is also helping developing countries, such as Tibet, map their land use changes surrounding villages by allowing local people and historical documents to help a GIS cartographer delineate land use changes over time (Bauer 1999).

A primary focus of recreation management use of GIS in the past has been monitoring campsite distribution within a large recreation area (Gajda et al. 2000). In association with monitoring where the campsites are, the amount of site degradation is recorded in order for managers to visualize and evaluate possible solutions. Areas with a high amount of use could be examined for limiting visitor use or restoration projects.

GIS has also been used in mapping social values of ecosystem services through the development of a GIS application called Social Values for Ecosystem Services, or SolVES in short (Sherrouse et al. 2011). By creating a new GIS tool, researchers made a new use for GIS that can be downloaded and applied for free by anyone who wishes to use it. New applications are being developed every day and managers should not overlook the value GIS can have for making decisions and development plans.

In 1999, the Journal of Parks and Recreation Administration published several articles outlining uses of GIS for parks and recreation management (Leun & Marion 1999 and Nedovic-Budic et al. 1999). However, the majority of the uses outlined in publications to date focus more on the large-scale applications (wilderness-wide or throughout multiple parks) that require moderate to advanced working knowledge of GIS. Some managers may not have the amount of GIS knowledge or the amount of geo-spatial information needed to conduct larger GIS projects.

We set out to see how GIS could be used on a smaller scale by parks and recreation managers within a small, focused management area. A simple problem such as where to place amenities for maximum visitor use can be evaluated with GIS. While it would take a large scale project to establish solid nation-wide conclusions, uncomplicated GIS and statistical calculations are enough to analyze and monitor amenity use to estimate changes for improvement. A manager can choose an amenity with an estimated geo-spatial relationship to visitor use, such as human waste found in the landscape in relation to a porta potty, and start monitoring for that relationship.

Riparian resource managers face the complex task of preserving environmental quality against many resource pressures. Grazing, water diversions, water-based recreation and water pumping are all stressors on the riparian environment. Water-based recreation within the arid lands of Arizona attracts the public to recreate within the relatively rare riparian zones (Moore 1989). With the increase in Arizona's population land managers are seeing a growth in demand for water-based recreation (Manning & Valliere 2001). More people recreating within a fragile ecosystem equate to further stress on the environment and leads to a need for recreation management to prevent irreversible ecological damage (Quinn 2002).

We chose to focus on a rare riparian ecosystem in Arizona that is also a popular recreation area as an example of a simple GIS human impact evaluation site. Our main objective was to demonstrate the applications of GIS for a small recreational area. We chose to use GPS and GIS applications to examine specifically the amount of human waste (diapers, toilet paper and feces) in relation to distance from informational signs, distance from porta potties, and vegetation type the evidence was found in. We estimated that the further a person gets from a sign/porta potty they will be more likely to not use the porta potty. We also tested if people are more likely to not use a porta potty in a vegetated environment compared to bare ground surroundings. Parks and recreation solutions, such as monitoring human impacts to manage a fragile riparian ecosystem, can be found using GIS.

Study Site

Fossil Creek is located in the Coconino and Tonto National Forests approximately 100 miles from Phoenix, Arizona. The creek emerges from Fossil Springs, is about 17 miles long and was designated a Wild and Scenic River in March 2009. Emily Anderson, a Masters student working for the Forest Service in conjunction with Northern Arizona University, focused her research on mitigating human waste problems in wild land recreation, concentrating on Fossil Creek. Her research provided the GIS coordinates and plot boundaries which were used in this study. Coordinates were taken using a GPS unit and boundaries around each site were designated and drawn on aerial photos of the sites. Of the evidence found in the sites, 93% were toilet paper, 4% human waste, and 3% diapers (Anderson 2011).

According to the Coconino National Forest website, over 1000 people recreate within the riparian area every weekend during the popular summer months. So many people recreating in one area stresses this unique ecosystem and leads to degradation of the land (Weber & Berrens 2006). Some examples of overuse impacts include: vegetation trampling, incorrect garbage disposal, degraded water quality, and inappropriate human waste disposal. Even with new porta potties installed, the amount of human waste produced in one popular weekend threatens to take over the landscape. Unmanaged recreation use has the possibility of affecting streamside soils, plants, and wildlife habitat, along with decreasing the recreation value of Fossil Creek for other users. Without modifications in visitor behavior recreation management, Fossil Creek has the potential to become degraded beyond the point of restoration. The Forest Service needs to take action to prevent the long-term loss of creek values.

With Fossil Creek designated as a Wild and Scenic River, managers must re-evaluate and change the management of Fossil Creek in order to preserve the environment while restricting current recreation use as little as possible. Current management ideas new to the area include strategies such as: charging year-round fees, limiting access to certain areas by only allowing a shuttle system drop off, installing composting toilets, and limiting group size and access.

While the management ideas are useful and should help stem the amount of human waste in the ecosystem, they are expensive and highly debatable procedures that are being met with some scrutiny by the public. Some cheaper and easier solutions might exist that managers have yet to expand upon, such as using GIS to monitor and evaluate why visitors are not using the porta potties provided by the US Forest Service. Keeping this in mind, we examined some of the spatially related variables that may help improve human waste management at Fossil Creek.

Methods

A wide range of factors could cause a visitor to not want to use the porta potty: distance, cleanliness, past experiences, nearby more favorable options, and enforcement of the rules could all contribute to a visitor's non-use (Anthony & Dufresne 2007). A visitor's beliefs and attitudes towards porta potties would require a complex social research project that some land managers may not be able to afford. Geo-spatial variables, such as distance and vegetation cover, can be measured with little to no cost to the land manager to help understand visitor behavior.

To begin geo-spatial analysis, managers must first determine which variables to measure. Within Fossil Creek the variables that logically seemed to be the most influential are the distances from porta potties and the vegetation cover. It seems that people would be less willing to use the porta potty if they are further away from it or if more favorable options (vegetation cover) are nearby. Another variable that could influence visitor behavior is the presence of signs, which symbolize authority and human presence. Visitors may feel less welcome to not use the porta potties around signs with regulations posted on them.

To examine the distance variable, the manager must first determine what distance counts as “far” from the porta potty. Every person has their own limits as to how far they are willing to walk to use a porta potty. In this evaluation, distance was broken up into three categories: 15 meters radius as “near”, 75 meters radius as “medium”, and the rest of the distance away as “far”. We determined the near measurement distance by examining how far away from a porta potty could visitors be at Fossil Creek before they would have to be trying really hard to not see it. The medium measurement distance was measured as the distance visitors could usually still see the porta potty through and around the mesquite vegetation. After visitors trek further than 75 meters from the porta potty, they would have to rely on their memory or instinct to know where to find it. Each distance can be changed and manipulated depending on the manager’s experience and judgment (Figure 1).

Vegetation cover was classified as “vegetated” and “bare ground” so that it could be measured by either a personal walk around the perimeter or by using a background picture/aerial photo to delineate the border. Again, this uses the land manager’s judgment and can be delineated or changed to a manager’s opinion and experience. For this example we used aerial photos to delineate the bare ground areas within our plot boundaries(Figure 2).

Signs were evaluated with just the “near” category of 15 square meters. Visitors should only be influenced by signs if they are nearby and will not go looking for a sign when another objective is on their mind. Regulations and authority must be conveniently and strategically located in order to communicate to visitors(Figure 3).

The Fossil Creek recreation area was divided into seven study sites, one for each major area most commonly used by visitors: Waterfall Trailhead, Irving Trailhead, Tonto Bench, Sally May, Old Corral, Fossil Creek Bridge, and Homestead. Plot boundaries were added in order to define the scope of the data collected. We focused our evaluation on seven of the most popular attraction sites. Each of the seven sites examined had an informational sign and one porta potty installed, with the exception of the Old Corral site which had two porta potties. Every porta potty was located within or near the designated parking area, which ranged 10-40 meters from the creek's edge.

Using a GPS, human waste evidence plots were counted during the months of March through October in 2009 by Emily Anderson, during which the porta potties were on each of the sites. Locations of the porta potties and the signs were also collected with the GPS. We took the data from Emily Anderson and analyzed it using ARC GIS. Buffers were added around the porta potties and signs following the "near", "medium" and "far" guidelines. Areas of each boundary and buffer were calculated using the ARC GIS measuring tool.

[Insert figure 1 here]

[Insert figure 2 here]

[Insert figure 3 here]

Assuming each point of human evidence occupied a 1 meter square, the amount of 1 meter square areas within each buffer zone was counted as human waste "present" or "absent".

The number of present or absent points was used in a chi-square test in order to test the null hypothesis that there was no relationship between the human waste evidences and distance from the different management amenities or the type of vegetation the evidence was found in. A chi-square test is the easiest method to determine if two or more categories are statistically independent (Corder & Foreman 2009). A 0.05 level of significance was used in the chi-square test for each of the three variables.

Results

The results are from the GIS test example for Fossil Creek and are split up into the three variables that were tested for relationships with human waste evidence: distance from signs, vegetation type, and distance from porta potties. Each site had only one sign and one porta potty placed in various locations within the boundary, the only exception being Old Corral with two porta potties present. Each site had various amounts of bare ground due to parking areas, campsites, trails, and understory loss caused by repeated car and human trampling.

[Insert Table 1 here]

The Waterfall site, which is located furthest east from the current Fossil Creek entrance, showed a significant relationship between the distance from the porta potty and waste evidence. Out of the evidences observed, 2% were found near the porta potty, 49% in the medium distance, and the remaining 49% was in the far distance. The Waterfall site did not show a significant relationship between vegetation cover and waste evidence. Only 10% of the evidences found were located in bare ground areas. There was a significant relationship found for the Waterfall site between sign distance and human waste evidence. Only 1% of evidences found were located near the sign.

The Irving site displayed a significant relationship between the distance from the porta potty and waste evidence. There were 23% of the human waste evidences found near the porta potty and 87% located in the medium distance. There was no far distance recorded for the Irving site because the site was small enough to have no distance far enough away from the porta potty to be counted as far. The Irving site did not show a significant relationship between vegetation cover and waste evidence. Exactly half of the evidences found were in vegetated areas with the other half located on bare ground. There was no significant relationship found between waste evidence and distance from signs. Out of the evidences observed, 24% were located in the near distance with the remaining 76% in the far distance.

A significant relationship between distance from the porta potty and waste evidence was found for the Tonto site. Only 4% of evidences occurred in the near category, with 26% in the medium and 70% in the far areas. There was not a significant relationship found involving the vegetation cover with 86% of waste evidences occurring in the vegetated areas. Tonto did have a significant relationship between waste evidence and distance from signs as 4% of evidences were found in the near category.

The Fossil Creek Bridge site exhibited a significant relationship between the distance from the porta potty and waste evidence. There were 10% of the evidences discovered near the porta potty, 15% at the medium distance, and 75% at the far distance. There was also a significant relationship found between vegetation cover and waste evidence. 5% of the evidences found were located on bare soil. There was not a significant relationship between waste evidence and distance from signs with 3% of the evidences found near the signs.

The Homestead site supported a significant relationship between distance from the porta potty and waste evidence, with 2% of the evidences found near the porta potty, 15% at the medium distance and 83% at the far distance. There was not a significant relationship found involving the vegetation cover with 82% of waste evidences occurring in the vegetated areas. Homestead did not have a significant relationship between waste evidence and distance from signs, with 3% of evidences found in the near category.

A significant relationship between distance from the porta potty and waste evidence was found for the Sally May site. Only 19% of evidences occurred in the near category, with 19% in the medium and none in the far areas. Sally May did not have any far distances because the site was small enough to have no distance far enough away from the porta potty. The Sally May site did show a significant relationship between vegetation cover and waste evidence. Evidences found in bare ground areas comprised of 18%. There was a significant relationship found for the Sally May site between sign distance and human waste evidence. 14% of the waste evidences were located near the sign.

The last site, Old Corral, displayed a significant relationship between distances from the porta potties and waste evidence. Out of the evidences observed, 13% were found near the porta potties, 40% in the medium distance, and the remaining 57% was in the far distance. . The Old Corral site did not show a significant relationship between vegetation cover and waste evidence, with 26% of evidences found on bare ground surroundings. There was no significant relationship found between waste evidence and distance from signs. Out of the evidences observed, 4% were located in the near distance with the remaining 96% in the far distance.

In total, every site showed a relationship between distance from porta potties and waste evidence. For the relationship between waste evidence and vegetation cover, the Homestead, Sally May, Old Corral, average number of evidences of human waste for all the sites, and the combined site total had a chi-squared value that indicated a significant relationship. At the Waterfall Trailhead, Irving Trailhead, Tonto Bench, and Fossil Creek Bridge found that waste evidences are independent from vegetation cover. Examining the relationship between human waste evidence and distance from signs, only the Waterfall Trail Head, Tonto Bench, Sally May, and average of all the sites showed a significant relationship. The Irving Trailhead, Fossil Creek Bridge, Homestead, Old Corral, and combined site total did not reflect a relationship between human waste evidence and distance from signs.

Discussion

After examining the results, we determined that distance from the porta potties in Fossil Creek seems to be the most influential geo-spatial variable that influences visitors to not use the porta potties. This could be because of the high number of "far" distances within plots due to placing the porta potties in areas that do not maximize visitor use convenience. Moving the porta potties to capitalize on the amount of "near" and "medium" space may encourage more visitors to use the porta potties instead of the surrounding environment. Adding an additional porta potty on larger sites is another way of accumulating more "near" and "medium" space into a plot, with the hopes of again attracting visitor porta potty use.

The signs seem to have no effect on porta potty use, perhaps due to the large amount of information posted on them at the kiosk hubs. Smaller signs that are focused on regulating human waste may be more effective in encouraging porta potty use. Small reminders to visitors about area regulations in a spot of previous high-frequency use may be all that a visitor needs to make the extra effort and use the porta potty.

Vegetation, on average and total, did have a significant impact on porta potty use. It makes sense that people would rather go to the bathroom in more private surroundings than out in the open. Placing signs, porta potties, or even jackstrawing some mesquite branches down to lessen the ease of access in high-frequency human waste areas could encourage visitors to use the porta potties more often.

These results should not be interpreted as a general relationship for all recreation sites and porta potties. The primary purpose of this evaluation was to demonstrate the possible applications of GIS as a recreation management tool. More information, such as the number of people who chose to use the porta potties, the number of people recreating at each site, if a specific site is more heavily used than another, and peak crowding times near the porta potties, would need to be gathered in order to make any solid relationship conclusions. Even then, many other difficult to measure social variables could influence visitor's use of the porta potties. The chi squared test in itself is not powerful enough to ensure statistical relationships of high significance and additional sites other than Fossil Creek would have to be investigated to support a general relationship statement between visitor non-use of porta potties and distance from amenities or vegetation.

This, however, should not detract from the relevance of how useful simple combinations of GIS and statistics can be to managers. In an age where budgets and time restrictions limit the amount a manager can accomplish, quick and undemanding evaluations for possible solutions need to be examined and utilized. If a solution to human waste frequency is as simple as moving a porta potty to a more generally accessible location, then why not try it before relying on more drastic (and typically more expensive) measures?

For land managers, a GIS and any variable relationship test can be applied to different problems such as litter distance from trashcans and cigarette butt distance from ashtrays. As long as a geo-spatial relationship can be tested simply with the use of a GPS unit, employing GIS for management solutions should be considered as an easy and cheap beginning for monitoring.

It is also recommended that monitoring be continued after management decisions have been made using GIS. If a porta potty is moved to another more generally accessible spot, locations of human waste evidence should continue to be recorded into the next season to insure the accuracy of the GIS results. With so many variables possibly influencing visitor behavior and use of porta potties, the site-specific distance conclusions will need to be re-evaluated if the geo-spatial changes fail to alter visitor behavior and compliance.

While the results did not find a strong relationship between distances from Fossil Creek signs and human waste evidence, new measurements with experimental signs could also be examined using GIS. In areas of high waste frequency managers could install a new, smaller sign that reminds visitors to use the porta potties. After installation, new human waste data could be collected and analyzed with the same methods used in this paper. The sign effectiveness estimation is important to know for land managers in order to make future sign decisions.

Land managers face a scope of difficult decisions when documenting and influencing visitor behaviors. Many of these decisions have to be made on intuition and experience with very little guidance on the monitoring objectives. Utilizing GIS to measure and monitor geo-spatial variables can aid managers and be a useful tool in extrapolating visitor management activities.

References

Anderson, E. J. (2011) Mitigating human waste problems in wildland recreation: a Fossil Creek case study. A Thesis submitted in partial fulfillment of the requirements for the degree of Master of Arts in Sustainable Communities. Northern Arizona University.

Anthony K.H., Dufresne M. (2007). Potty Parity in Perspective: Gender and Family Issues in Planning and Designing Public Restrooms. Journal of Planning Literature. 21:267-294.

Bauer, K. (2009). On the politics and possibilities of participatory mapping and GIS: using spatial technologies to study common property and land use change among pastoralists in Central Tibet. Cultural Geographies. 16:229-252

Borrie, W.T. (2000). Impacts of technology on the meaning of wilderness. Personal, Societal, and Ecological Values of Wilderness: Sixth World Wilderness Congress Proceedings on Research, Management, and Allocation. USDA Forest Service, Rocky Mountain Research Station. RMRS-P-14.

Corder, G.W. and Foreman, D.I. (2009). Nonparametric Statistics for Non-Statisticians, a step-by-step approach. John Wiley and Sons, Inc., Publication. 168 p.

Gajda, A.M., Brown, J., Peregoodoff, G., and Bartier, P. (2000). Managing Coastal Receration Impacts and Visitor Experience using GIS. USDA Forest Service Proceedings RMRS-P-15-VOL-5.

Kliskey, A.D. and Kearsley, G.W. (1993). Mapping multiple perceptions of wilderness in southern New Zealand. Applied Geography. 13(3): 203-223.

Landres, P., Spidle, D.R., and Queen, L.P. (2001). Wilderness Management: Potential Uses and Limitations. USDA Forest Service Rocky Mountain Research Station General Technical Report. RMRS-GTR-80.

Leun Y., & Marion, J. (1999) Spatial Strategies For Managing Visitor Impacts In National Parks. Journal of Park and Recreation Administration. 17(4): 20-38.

Manning R., & Valliere W. (2001). Coping in Outdoor Recreation: Causes and Consequences of Crowding and Conflict Among Community Residents. Journal of Leisure Research, 33(4): 410.

Moore S. (1989). Leisure Sterotypes: Person Perception and Social Contact Norms in a Wilderness Area. University of Arizona Dissertation Library.

Nedovic-Budic Z., Knapp G., & Scheidecker, B. (1999). Advancing the Use of Geographic Information Systems for Park and Recreation Management. Journal of Park and Recreation Administration. 17(4): 73-101.

Quinn T. (2002). A public utility model for managing public land recreation enterprises. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 22 p.

Rowland, M. and Connolly, M. (2002). Torwards GIS Mapping and Spatial Modeling of Archeological Sites in the Southeast Queensland Bioregion. Environmental Protection Agency. 13: 39-62.

Sherrouse, B.C., Clement, J.M., Semmens, D.J. (2011). A GIS application for assessing, mapping, and quantifying the social values of ecosystem services. Applied Geography. 31:748-706

Weber M., & Berrens, R. (2006). Value of Instream Recreation in the Sonoran Desert. Journal of Water Resources Planning and Management. 132(1): 53.

Acknowledgements

I thank Emily Anderson for the use of her data, Derek Sonderegger for his help in statistics and Mitchel Day for his input and support with ARC GIS. Finally, I would like to thank my parents for their never-ending support and for encouraging my interests in arts and science.

Table 1. Comparison of each site observed values (number of specific evidences of human waste found) in relation to porta potties, vegetation, and sign distances and their associated chi-squared values. A * designates a chi-squared value that indicated a statistically significant relationship.

	Porta Potty Distance				**Vegetation**			**Sign Distance**		
Site Name	Near	Medium	Far	x^2	Vegetated	Bare Ground	x^2	Near	Far	x^2
Waterfall	8	259	65	19.503*	298	34	4.561	4	328	11.424*
Irving	6	20	0	7.673*	13	13	1.555	5	21	0.017
Tonto	16	101	297	8.43*	343	53	4.849	18	378	9.278*
FC Bridge	9	14	71	19.348*	89	5	4.094	3	91	0.644
Homestead	21	135	737	140.54*	736	157	150.48*	26	867	1.658
Sally May	35	153	0	36.796*	154	34	11.465*	27	161	8.271*
Old Corral	56	169	337	19.046*	451	111	20.129*	10	417	4.939
Total	151	851	1489	40.607*	2084	407	109.851*	93	2263	0.602
Average	21.57	121.57	212.714	35.905*	297.71	58.14	28.162*	13.29	323.29	5.176

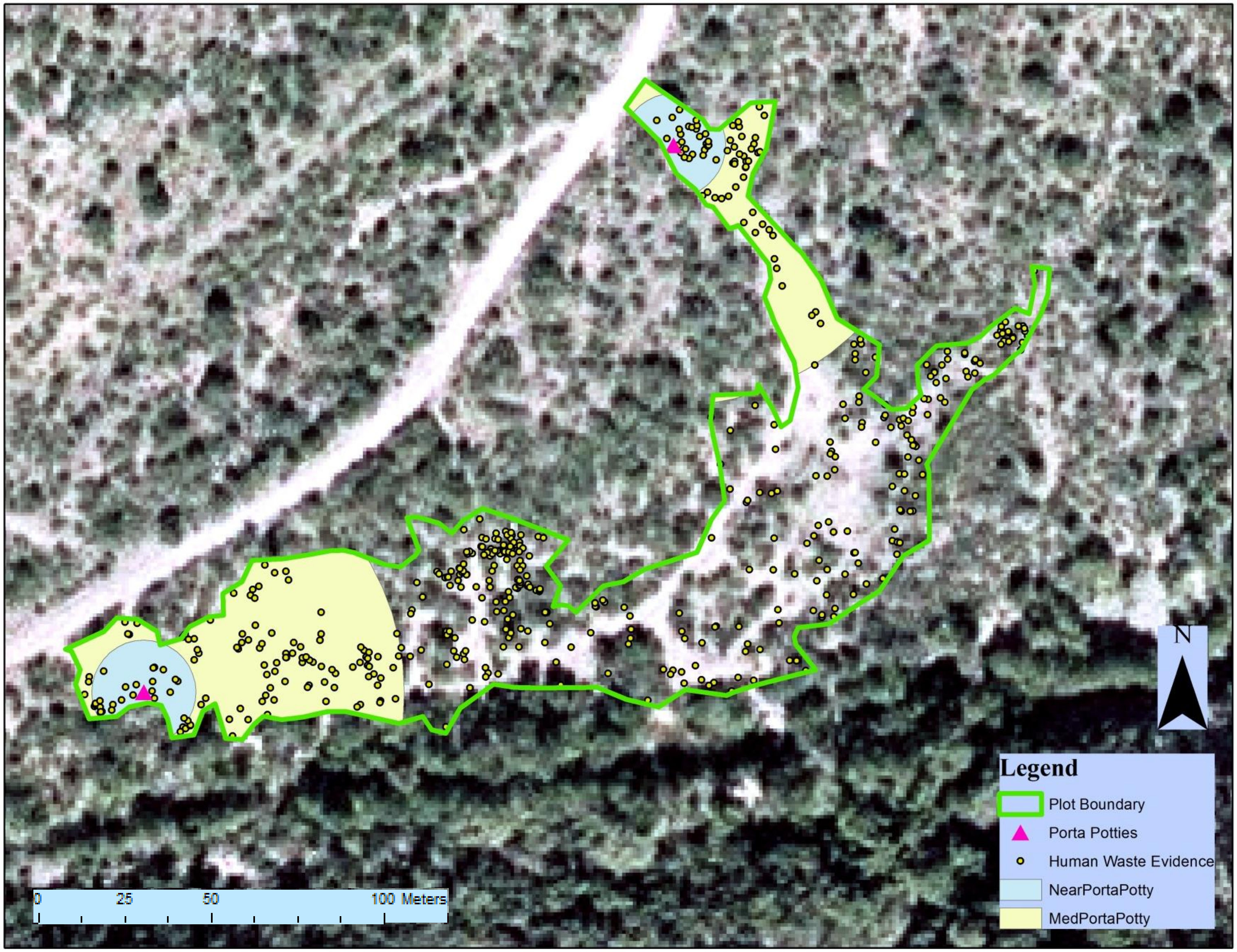

Figure 1. Map of Old Corral plot with human waste evidence and porta potty near and medium buffers.

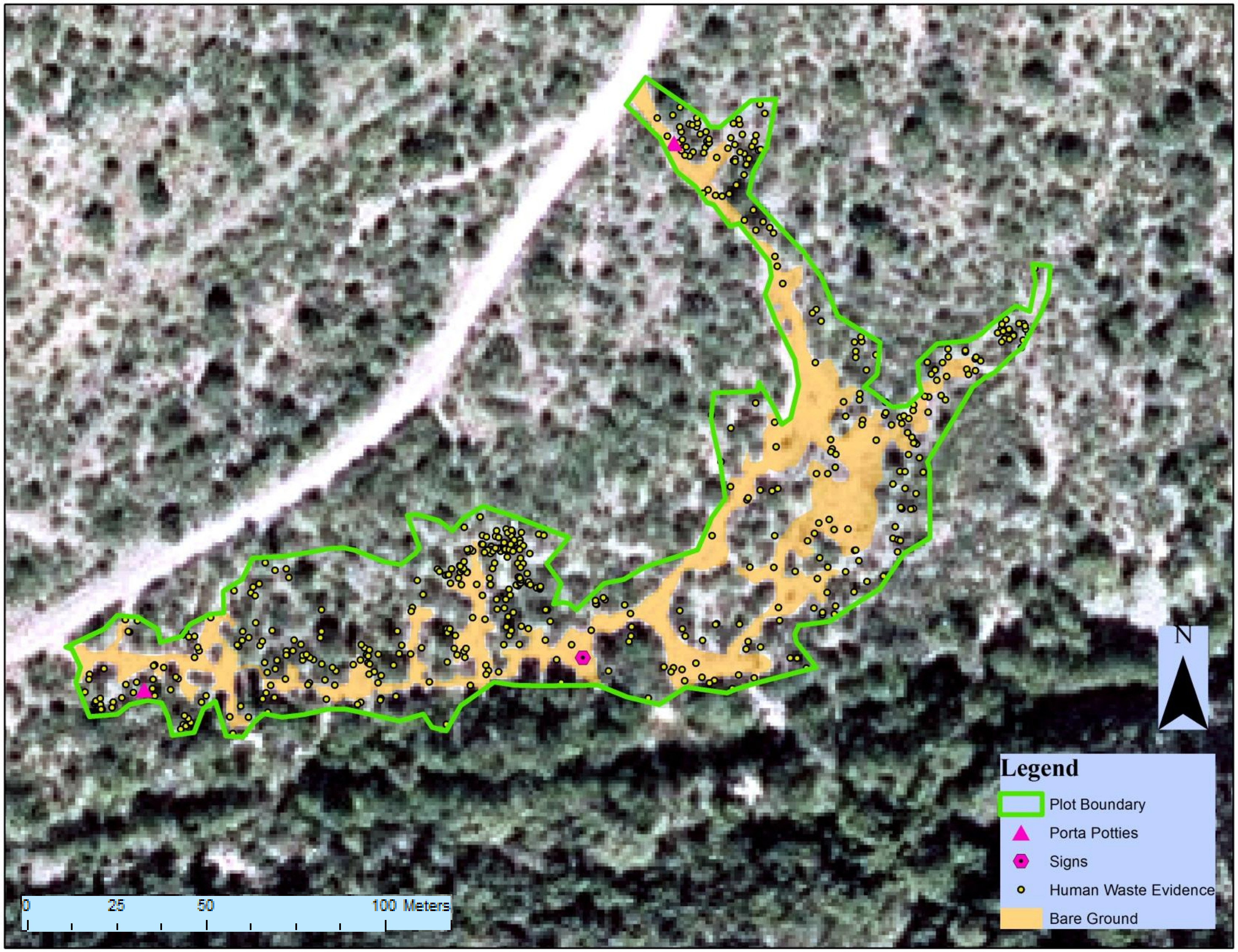

Figure 2. Map of Old Corral plot with human waste evidence and bare ground buffer.

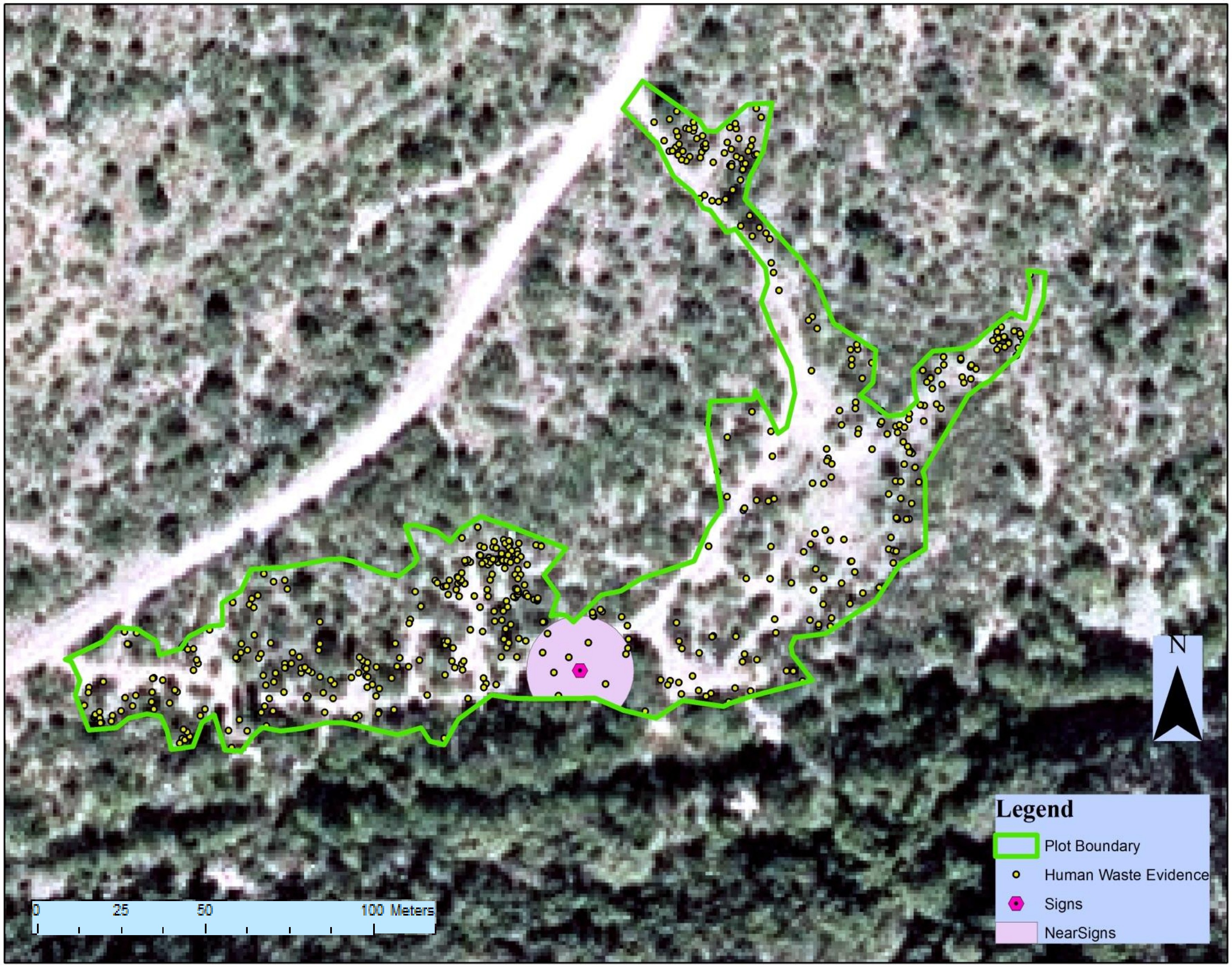

Figure 3. Map of Old Corral plot with human waste evidence and sign near buffer.