

COMMENTARY

Conducting urban ecology research on private property: advice for new urban ecologists

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Submitted: 6 August 2018; Received (in revised form): 14 November 2018; Accepted: 1 January 2019

Abstract

Private property makes up a large proportion of urban green space and differs from public green space in ecologically important ways. While including private property in urban landscape research is necessary, ecologists are frequently unprepared to work on private property and thus often exclude private land from empirical studies. To address this gap and encourage research on private property, we ask: ‘What lessons have urban ecologists learned from designing their research and completing their fieldwork that are relevant to researchers new to private property?’ We present 10 common methodological and practical challenges faced by urban ecologists, with solutions synthesized from semistructured interviews with 24 urban ecologists from 7 countries, along with public health researchers and police officers. The compiled advice addresses all stages of research, including research design, sample design, gaining access to study sites, collecting data on study sites and sharing results. Ecologists reported that their research and sampling design were shaped by the need to work with property owners, found communicating honestly and respectfully with property owners for the duration of the research influenced success, and emphasized practicing good field safety and preparing for both routine and stressful in-person encounters. Further research and collaboration among ecologists and private property owners is necessary to improve our understanding and management of urban ecosystems given the proportion of urban green space that is on private property. We hope that our suggestions will help guide the next generation of urban ecologists to take up this challenge.

Key words: private property, residential, land use, commercial, lessons learned

Introduction

Private property makes up a large proportion of urban green space in many cities and is important for maintaining biodiversity and ecosystem functions and services in urban areas (Hilty and Merenlender 2003; Loram et al. 2007; Cerra 2017). Research increasingly shows that ecological patterns and processes on private green space can differ from public green space in ecologically meaningful ways (Edmondson et al. 2014; Belaire, Westphal, and Minor 2016; Ziter and Turner 2018). For example, researchers in Leicester, UK, found that the presence of trees

increased soil organic carbon stocks in residential yards more than on public land (Edmondson et al. 2014), and research in Madison, Wisconsin, USA, showed that both temporal trends and spatial variability of three soil-based ecosystem services differ in private yards compared to public green spaces (Ziter and Turner 2018). Patterns within private property can also yield insights into urban ecology. A multi-city study of residential landscapes found that back yards had higher species richness than front yards (Locke et al. 2018), highlighting the leverage that urban residents have to enhance biodiversity conservation.

Thus, including private property in research programs is necessary to fully understand the ecology of heterogeneous urban landscapes.

Despite this need, ecologists are frequently unprepared for, or wary of, working on private property. Managing access to a sufficiently large sample of study sites is difficult and requires approval from multiple parties as property ownership is fragmented both in space and time due to changes in ownership. Appropriate communication with landowners and managers around project goals and results demands additional time, resources and effort. Safety of researchers and field assistants may be a greater concern than when working on public land. Consequently, many urban landscape studies are limited to public green spaces such as parks (McDonnell et al. 1997; Tonn and Ibáñez 2016) or use designs that eliminate the need to ask for permission to access private property (e.g. remotely sensed data: Loram et al. 2007; Walker et al. 2017; limiting study sites to publicly viewable front yards: Melles, Glenn, and Martin 2003; Lowenstein and Minor 2016).

While such methods can yield important insights, research assessing private property without involving the property owners or obtaining permission (e.g. via roadside observations or taking photos) can also create conflict with residents (as in Beumer and Martens 2016) and precludes many types of sampling and research designs. These challenges can lead to exclusion of private land from empirical studies, with many types of private property lacking representation in the literature (Davies et al. 2011; Strohbach and Haase 2012). Due to ecological differences among urban land use types, this lack of representation could bias our understanding of urban ecosystems.

To facilitate the inclusion of private land in urban ecology research, it is necessary to understand common questions and challenges and their solutions. Here, we identify and summarize common challenges and their solutions for ecologists considering urban ecology research on private property, drawing both from the experiences of urban ecologists who have successfully completed private property research and from disciplines that work with people and their communities. We ask, ‘What lessons have urban ecologists learned from designing their research and completing their fieldwork that is relevant to researchers new to private property?’ We present 10 common methodological and practical challenges faced by urban ecologists, with solutions synthesized from semistructured interviews with 24 urban ecologists from 7 countries, along with public health researchers and police.

We define private property as property owned by an individual or nonstate agent (e.g. corporation) where the owner’s rights include limiting the use, management of and access to the property (Schlager and Ostrom 1992). Though some of the advice is applicable, we do not explicitly address challenges unique to survey design or community science and volunteer management, or to exurban and agricultural private property (Hilty and Merenlender 2003).

Methods

We interviewed researchers of urban landscapes who negotiated access to private property for their research. We used purposive sampling of professional outlets, scientific literature and social media, coupled with snowball sampling to identify possible interviewees. We interviewed researchers regardless of study organism, habitat type, geographical location or methods used to ensure a widely applicable set of lessons for urban ecologists working on private property and minimize our own

biases. In total, we interviewed 26 urban ecologists from 7 countries including multiple regions throughout the United States, along with two researchers in public health and two police officers. Twenty-four ecologists’ responses provided useable data, while further discussions with two ecologists found their work was not on private property as defined here. Research took place on residential and commercial property, in yards, parking lots, green roofs, ponds and irrigation ditches. Study focus included vegetation, soils, aquatic and terrestrial insects, birds, fungi and mammals. Despite these diverse experiences, we achieved a remarkable redundancy in the problems and lessons learned (Baxter and Eyles 1997).

We established email communication with each potential interviewee, described our research and questions, and obtained written consent to be interviewed for the paper. We then verbally reiterated the goal of the study and how the information interviewees shared would be used at the start of each interview. The University of Washington Human Subjects Division granted a ‘Determination of Exempt Status’, finding that the research is exempt from the federal human subject regulations. The IRB approval number is STUDY00000728.

We conducted open-ended interviews with all individuals using the ‘expert’ interview technique (Dexter 1970; Harvey 2011). Briefly, a core set of open-ended questions acts as a template for a semi-structured interview. The interviewer uses these questions to guide in-depth discussions based on what the interviewee thinks is important and their areas of experience. Our core set of open-ended questions for urban ecologists covered all phases of a research program and centered around problems that the interviewee ran into, how these were addressed, what worked well and what the interviewee would do differently if repeating their study. Researchers in public health were asked a subset of these questions focused on what worked well for community engagement and data sharing. Police officers were asked for advice on alerting police to the researchers’ presence and on interacting with police in the field after urban researchers frequently reported police encounters during their work.

Our analysis of the research data was an applied qualitative approach also used in applied policy research (Ritchie and Spencer 2002). It is driven by answering one central question: ‘What lessons have urban ecologists learned from designing their research and completing their fieldwork that is relevant to researchers new to private property?’ It is not designed to generate theory or analysis of the researchers themselves, but instead to highlight problems other researchers have encountered and how they addressed them. Though not generalizable, we provide descriptive statistics of our sample to illustrate the prevalence of key challenges.

Results: practical advice from experienced researchers

What should I consider when designing research for private property?

Urban ecologists considered multiple issues when designing their research (Table 1). These include:

Legal compliance including photos: Ethical and legal compliance may limit methods choice. For example, both researchers using camera traps found that urban camera trap images often include people, and one researcher noted that photos including children may be restricted by law. For publication, all fieldwork images require extra scrutiny to protect identifiable information

Table 1: Brief overview of common problems and their potential solutions identified by experienced urban ecology researchers

Result	Common problem	Potential solutions
3.1	Problems in research design: Privacy concerns Risk of property damage Discovering risk on property Imposing on property owner Destructive sampling Leaving equipment on site Methodological scale or spatial mismatch Mismatch in official/as managed boundaries Inexperience with urban systems Community engagement methods unfamiliar	Strip GPS coordinates/metadata from photos, obscure identifying information. Design sampling methods to minimize property damage, in consultation with landowner if possible. Report illegal activity to property owner. Consider how your research might affect property values and owner liability. Use fewer or shorter visits; shift research time. Be prepared to address owner concerns re: wildlife handling. Publicly accessible sites often more vulnerable than private. Must consider natural unit of analysis in urban context (often parcel); wildlands analysis often inappropriate. Choose one and be consistent. Do pilot study, even if reduced in scale. Explore community-based participatory research; provide value to communities where you will work.
3.2	Obtaining adequate sample size	Account for rejection and non-response during site selection, as well as potential loss of sites during project.
3.3	Unsure how to contact property owners	Mail requests using available database for address; visit property in person; partner with existing groups.
3.4	Unsure how to contact unique properties	Industry conferences, cold calls, and snowball sampling.
3.5	Sample selection bias & measurement bias	Quantify acceptance rates across different land use types; be aware of limitations of non-probability sampling. Quantify any interaction effects based on land use.
3.6	Field work preparation	Be prepared to present research, methods, and timeline to property owners; discuss any known site hazards or access restrictions. Get signed permission forms and make copies.
3.7	Multi-visit/year studies	Communicate clearly with owners/managers for the project duration. Change in ownership or management requires re-starting your communication plan.
3.8	Research ethics	Remember that you are conducting research where people live and work. Read and incorporate ethical guidelines from other disciplines.
3.9	Interactions with people while doing research	Safety: Work in pairs and have a detailed researcher safety plan.; leave if you are afraid or asked to leave. General: Dress like a researcher; be prepared to share study information or credentials. Have an 'elevator speech' about you and your research.
3.10	Unsure how to conduct post-study outreach	Plan for time and cost of outreach in grant or choose low cost options (e.g. email); always thank participants. Include results specific to property/neighborhood; emphasize their contribution to study.

of property owners. Addresses, license plates and signs may need to be obscured; GPS coordinates should be stripped from image metadata.

Potential for property damage: Research methods may cause property damage. For example, of seven researchers contemplating soil sampling, two reported avoiding research methods that required digging; one cited a colleague's experience damaging an irrigation system that required costly repairs. Five others successfully collected soil samples. Both researchers considering tree aging chose not to core trees, or reduced the number of cores taken, to avoid damage or blame for potential future tree injury (Norton 1998). Three researchers altered vegetation and insect sampling designs to avoid property damage. Carefully consider the potential of your methods to cause property damage and consider changing your sampling methods to avoid problems. Always inform property owners of methods you are using, so they will know what to expect. If potentially damaging methods are required, cultivate good relationships with property owners and work with them to avoid potential damage, for example by using different tools like hand spades or asking about irrigation systems.

Hazard discovery: Two researchers reported avoiding soil analyses that could reveal heavy metal contamination and trigger property owner liability or disclosure requirements.

Encountering trespassers or illegal activity, or recording such things via camera, is also a potential hazard and was reported by four researchers. Report any observed illegal activity to the property owner. Consider how your research might affect property values and owner liability, and where possible choose alternative methods. If methods that may discover risk on properties are required, not all owners will have the same risk tolerance; you may need to drop sites with lower risk tolerance or recruit sites with higher risk tolerance.

Imposition on the property owner: Fourteen researchers modified research designs to require fewer or shorter visits, or shifted the research start time to reduce imposition on the property owner. For example, researchers changed the length of bird counts to avoid asking for access twice, or delayed bird surveying until a time more convenient for property owners. Consider the likely imposition on the property owner and adjust your study design to reduce imposition where possible.

Destructive and invasive sampling: Two of three researchers using destructive (euthanasia) or invasive (bird banding) methods reported pushback from property owners. Based on interviewee experience, there was less pushback with frog sampling than bird sampling, suggesting organismal bias. If destructive sampling is necessary and an owner asks directly, be truthful about the need to kill organisms for the research. As with

methods that may damage property, property owners with whom the researcher has cultivated a relationship are more likely to be amenable to destructive or invasive data collection.

Leaving equipment on site: Of eight researchers that considered leaving equipment on site, only one researcher altered their study design to avoid it. Four researchers left equipment, but only on private or inaccessible locations, and they agreed that publicly accessible locations were more vulnerable to theft and vandalism. Equipment clearly marked 'science' may or may not be respected (see also [Clarín et al. 2014](#); [Meek, Ballard, and Falzon 2016](#)). Just as in more remote settings, urban livestock and wildlife can disturb equipment. If your research design requires it, carefully consider where you will be leaving equipment. Private or inaccessible sites are likely safer than publicly accessible locations.

Methodological scale or spatial mismatch: Some area-based methods commonly used in wildland research are not appropriate in the private property context where the parcel is often the natural unit of analysis. Two authors found that methods commonly used in their fields would change their unit of analysis. Common methods may require modification or replacement to avoid changing the unit of analysis from the parcel to that of the method—e.g. for birds, from parcel to the point count area. Methods may need to be adapted to fit parcel geometry (comparatively small and dominated by a central building).

Boundary issues: Official property boundaries and 'as managed' boundaries may not align; four researchers reported mismatches discovered in the field. Choose which to use based on your research objectives and be consistent.

Pilot studies: Pilot studies were used by five researchers, all of whom found them useful, particularly when working in urban systems for the first time. For example, one author discovered issues with bird detection which—in addition to unit of analysis mismatch—contributed to their use of the standardized search method over a traditional point count method ([Watson 2003](#)). Strongly consider performing a pilot study to field test your research design and methods, even if reduced in scale or on nonprobability sampled parcels.

Engagement and participatory research: Working on urban private property provides opportunities to involve property owners, organizations, residents and others in research using community-based participatory research and other methods. All ecologists answered questions from passersby and residents, nine mentioned people wanting to be involved in data collection, and one explicitly discussed community science. Only the researchers in public health specifically mentioned techniques like community-based participatory research. If used, provide value to participants (including food), use people's time wisely and focus on what they care about to get them involved. Accept that you will make mistakes—apologize immediately, don't get defensive and do better in the future. Collaboration is particularly important if your research is expected to have policy outcomes that could impact community members ([Israel et al. 1998](#); [Kramer 2016](#)).

How do I obtain an adequate sample size?

Each study site or unit of analysis requires at least one (and sometimes multiple) property owners to grant access, which complicates good sampling design practices in two important ways.

Rejection and non-response: First, sampling designs must account for property owner rejection or nonresponse to access requests. There are two main approaches to obtaining an

adequate sample size: either solicit more requests than needed to ensure n_{needed} are accepted ($n_{\text{solicited}} = \frac{n_{\text{needed}}}{\text{expected response rate}}$); or continue conducting rounds of requests until reaching n_{needed} . With the first approach, site selection protocols should be in place before contacting property owners in case the number of acceptances is greater than n_{needed} . Of our interviewees, 8 requested access to more sites than needed, and 16 conducted rounds of requests until their quota was met. Researchers using either approach frequently generate a list of potential sites larger than their target n_{needed} with the correct sample characteristics (proportion of land uses, distance to natural area, ownership, etc.).

Some sampling designs or study characteristics may be prone to high rejection and nonresponse rates. Lower acceptance rates may be caused by longer studies with multiple visits or more complicated study designs; study designs where each sampling point requires permission from a cluster of adjacent neighbors; and certain land use types, particularly those with more liability concerns such as commercial buildings.

Different strata in a stratified random sampling design may have different response rates; those with lower response rates must be solicited more frequently to obtain the desired sample size. Small strata also require special attention. One author addressed a particularly small stratum by modifying sampling site restrictions to this stratum and requesting access to every eligible site to receive access to enough sites.

Site retention: Second, some fraction of the sample sites may drop out once the study has begun. New owners may not provide consent following property turnover, existing property owners may withdraw consent, or data loggers might be lost, stolen or damaged. Sample sites may also need to be eliminated by the researcher for a variety of reasons, including hard to manage property owners. Eight of 11 researchers using a multi-visit design reported site loss during their study. We suggest designing your study such that dropping a site will not compromise your overall analysis or results.

How should I contact property owners for access?

There are multiple effective methods for contacting property owners to ask for property access. The most common approaches are mailed requests and in-person verbal requests; these approaches are not mutually exclusive.

Mailed requests: Eight researchers used mailed requests, with one citing previous hostile in-person encounters as the motivating factor. Mailings should be on professional letterhead and contain both a clear project description and explicit information about the proposed methods (using photos/diagrams if possible). If part of an ongoing research project, include previous results so property owners can see how their data will be used. Mailings should also contain an easy way for the property owner to respond, including a self-addressed and stamped postcard with yes/no checkboxes. A frequently used mailing protocol is the Dillman approach ([Dillman 1991](#)).

Some researchers have mailed requests or surveys including an access request to entire neighborhoods they are interested in sampling. While more expensive, researchers using this approach reported getting more volunteers than needed and could compare the yes/no property access groups.

Access requests can be mailed to the physical address associated with the property or with the property tax bill. For multi-family housing, commercial and industrial sites, requests to the address associated with the property tax bill may be more successful. In the United States, both addresses are accessible with

publicly available tax assessor's data. A proportion of mailed requests will be returned to sender due to incorrect address information.

In-person verbal requests: Fifteen researchers used in-person requests, including knocking on residential doors, approaching homeowners in yards or approaching commercial and multi-family residential front desk staff. Successful communication when approaching in person includes quickly identifying yourself as a researcher, a short, easily communicated research statement and a well-defined access request. Language and word choice are important; for example, one researcher found that 'student' and 'frog' were well received while 'chemistry' was not. Carrying contact information, institutional information and information about the project can also be useful. Day and time determine how many properties have someone available. Multiple researchers reported knocking on doors on the weekends/socially convenient times in residential areas or during business hours in commercial areas to increase response rates.

As with in-person interactions generally (see in-person section below), researchers encountered a range of reactions approaching property owners in person—including enthusiastic engagement, interest, indifference, confusion, suspicion and hostility. Five of the 15 researchers using in-person requests reported hostile or suspicious responses from at least one property owner. Mailing, emailing or otherwise advertising your intentions to be in the neighborhood may smooth your path. Researchers reported more positive in-person request reactions under certain circumstances: (1) they have good soft-skills; (2) there are good town–university relationships; (3) the population is environmentally conscious; (4) research is tied to local concerns and (5) local students are working on the project, particularly in smaller cities.

Note that when approached in person, some property owners will want to schedule a time for you to come back. Others may expect or want you to carry out the research right away, so be prepared to do your fieldwork.

Other contact methods: Eleven researchers used other methods, including master gardener associations, listservs (automated communal electronic mailing lists), Facebook groups, churches and community groups, partnerships with relevant retailers like garden stores and word of mouth to recruit part or all their property owners. Recruiting via local media or via groups not explicitly tied to the environment (e.g. neighborhood groups) may be more robust and less likely to produce responder bias (see next section). If you expect any volume of responses, consider setting up a web form to deal with them efficiently. Leaving pamphlets at a location had a very poor response rate for all three researchers who tried.

Researchers sometimes access private property without permission; for example, while following a bird or tagged animal across residential property boundaries without verbal or written consent. However, we cannot condone such an approach. Trespassing poses serious risks, both legally and to the researcher's safety.

Choosing a contact method: Consider access to mailing addresses, cost of recruitment, culture, willingness of homeowners to answer the door, land use type and study design when determining which approach to use. Researchers doing using in-person requests generally only sampled the property once and did not make significant 'asks' of the property owner. Written requests may be a better approach for longer-term or more complex research projects, though mailed requests had lower response rates than in-person requests. For example, one

author conducted a multi-visit, multi-year intensive sampling design. Three rounds of access requests were required to obtain the desired sample size; of 46 mailed requests, 20 were accepted, 6 were rejected and 20 received no response. For all methods, researchers must be sure that the person granting access has the authority to do so, particularly for multi-visit or intensive and invasive sampling.

How should I approach unique properties?

Some types of properties require specialized access or require additional credentials. For example, green roofs are relatively rare, and sampling involves increased risk and liability. Researchers successfully recruited properties to the study by networking at industry conferences and cold calling property owners or managers specializing in these properties to gain access to an initial group of sites, then using snowball sampling to build sample size when property owners could vouch for their ability to do the research safely and without damaging property. Though nonprobability sampling, nontraditional sampling methods like this may be the only way to recruit enough samples to complete the research. Researchers may also need additional credentials before they can approach some land use types. In England, for example, clearance from the Criminal Records Bureau (CRB) is required to conduct research on school property.

What types of bias should I watch for when sampling sites?

Sample selection bias: As with all ecological research, the end goal in sampling private property is an unbiased set of sample sites that will effectively address the research questions. Sampling bias occurs when different members of the target group are more or less likely to be included than others. Researchers should understand potential sources of sampling bias and mitigate them.

A key source of sampling bias occurs when different groups of property owners accept or reject access requests at different rates (Kho et al. 2009; Strohbach and Haase 2012). For commercial properties, some management companies have a blanket 'no access' policy. Homeowners may be biased in granting permission based on their level of environmental concern, interest in gardening, level of education, socioeconomic status, ownership structure (owner vs. renter occupied) and their relationship with your institution (prestige and reputation of the university). Funding partners and social or traditional media used as outreach platforms can also bias your sampling pool.

These biases manifest at different scales, including between neighborhoods and 'microscale' bias between adjacent households. Differences in conservation-oriented individuals may show up as spatial patterns; one researcher received acceptances from a larger than expected number of properties near parks and forests and had to implement new distance to park rules for additional sites.

Some researchers relied on nonprobability convenience sampling to find more sites and help intense research designs proceed. Researchers should be realistic about the potential for sampling bias to influence results and may want to quantify how sampled properties differ from others in the sampling frame.

Measurement bias when sampling: Scheduling times with private property owners (see next section) may introduce measurement bias. For example, surveying birds at parks at dawn

and at residential properties at mid-morning means time-dependent differences in bird behavior may confound your study design. One approach to evaluate potential bias is to add additional sampling visits to parks at mid-morning to quantify the effect of time. Additionally, some property owners may request you sample only in specific locations on their property, particularly if you are taking soil or other samples. Explaining bias, probability and the need to choose a random location in easy to understand terms is often enough to convince people to let you sample in the random location.

What can I expect from property owners when it is time to sample?

Coordination: As mentioned, when asking for access in person many property owners will expect you to conduct your sampling immediately. In most other cases, you will need to coordinate sampling with the property owner and visit at a time convenient to them. Do not underestimate the time and work required to coordinate with your property owners—particularly if your research is weather dependent or you are visiting multiple sites per day. Property owners may or may not want to be present, watch you sample or be notified when you arrive or leave.

Alert to potential hazards: Animals, including dogs, urban livestock and honeybees are common on residential property and can interfere with data collection or damage equipment. When making appointments with residential property owners, remember to ask if there are any animals present and how they should be handled. Be cautious, because residents may not communicate their presence.

Commercial property: Commercial property requirements tend to be more formal. Most commercial properties require notice of research visits (24–72 h is standard), and some properties may require written documentation. Even when not required, communicate with the owner or manager prior to visiting their property. Commercial access may also require signing a liability waiver. You should read these and all other documents carefully. You may need to drop the property from your study if the requirements are too onerous. In some instances (e.g. larger buildings, golf courses), someone may also escort you on the property for part of or your entire visit.

What can I expect with multi-visit/year studies?

Multi-visit—and particularly multi-year—designs are needed to further urban ecology (Lindenmayer et al. 2012). Eleven of the researchers we spoke with used a repeated sample design, seven utilized a multi-year design. Fifteen used single-visit study designs only. In these counts are two researchers who used both single- and multi-visit designs for different projects.

Communication: Researchers with multi-visit and multi-year studies found ongoing communication particularly important. Communication frequency and method should be tailored to each property manager or owner. Reminders about the start of a new field season are particularly important. It is good practice to contact properties 6–8 weeks in advance, so you can resolve any issues that arise or renegotiate access before data collection needs to begin. Researchers found that Twitter, email lists, blogs, websites and Facebook groups are all effective for communicating with groups of property owners, creating a community and encouraging continued engagement with the research.

Access loss: As mentioned in Question 3.2, access to study sites may be lost during a study, e.g. due to property manager

turnover or property sale. New managers/owners are not always told about ongoing research, and you may need to re-negotiate for continued access. Be prepared to adjust your communication style and frequency, sampling time and protocols based on new owner/manager requirements. Of 11 researchers using a multi-visit design, 8 lost access to at least one study site due to nonresponse or hostility of the new owners or managers.

Multi-visit designs also require accepting property alteration over the course of study more than single-visit designs. Alterations include moving or cutting down trees and shrubs and paving additional portions of the site. Consider how to handle changes before starting your research.

How can I work in neighborhoods ethically and respectfully?

Anthropologists have adopted ethical guidelines that are also applicable to urban ecologists (Anthropology Southern Africa 2005; Association of Social Anthropologists of the UK and the Commonwealth 2011; American Anthropological Association 2012). Key guidelines include: treating participants (property owners) as people, not subjects of research; that the researchers' primary responsibilities to participants are to protect them from harm, ensure informed and ongoing consent, and share research results; and that the researcher is also accountable to research assistants and students, colleagues and the public. For urban ecologists, these guides from anthropology are more relevant than many developed for ecology, which focus more on professional responsibility as a scientist (e.g. not falsifying results) and less on treating the communities in which ecologists work with respect (Ecological Society of America 2013). This is insufficient for a discipline that regularly interacts with communities and members of the public.

How can I prepare for in-person interactions?

Working on urban private property means frequent contact with residents, neighbors, tenants and passersby both during fieldwork and when approaching people in person to ask for property access. For your safety, strongly consider conducting research in pairs (or teams), preemptively greeting and introducing yourself to neighbors or tenants who might be suspicious, letting someone know the addresses where you are going and checking in with a trusted individual at set times. If team fieldwork is not possible, consider 'borrowing' trusted helpers (significant others, friends) when needed so that you are not alone when visiting a site. If you will be working in an area for a substantial amount of time, getting to know key community members can help build relationships and avoid confrontation with community members and police.

A framework for interaction: We find it helpful to frame interactions with other people on a four-point scale. These interactions will be colored by local attitudes and by how people perceive your gender, race, age and nationality, among other factors. A critical assessment of the target community and the researcher's relative position is essential prior to approaching properties to request permission in person or collect data. If you are not a local, consult other researchers or trusted individuals familiar with the area.

Level 0: Curious interest. The authors and all urban ecologists interviewed experienced people approaching to ask questions about their work, what they were doing, and ecology in general while they were in the field. Though these interactions can be time consuming, they are an investment in the site and

your research. Several researchers stated that they felt they were ambassadors for science as well as urban ecologists and valued the time they spent interacting with people. This is a more personal 'broader community impact' that you can't get via public lectures and other traditional outlets.

Level 1: Suspicious interest. Sixteen researchers reported encounters with people who were suspicious or challenged their right to be on the property. These situations occurred in multiple contexts, including: when one resident/owner had given consent to the research but did not inform other residents/tenants; with vigilant neighbors; and in a public space when assessing trees or something else people value. Most concerns were addressed and deescalated after researchers demonstrated that they knew the property owner or manager and had their permission to be on site.

Unfortunately, Level 1 interactions can also escalate if the person persists in their suspicion of you and your team or the organization you are with. Deep prejudices can lead to additional confrontation—both racism and antigovernment hostility have been encountered by researchers. If the person asks you to leave, it is generally best to do so, and you may need to drop the site for your own safety. When a neighbor seems irate or unreasonable, it may be more prudent to retreat and renegotiate a future sampling date when the property owner can be present. Asking the property owner to reach out to this neighbor may help.

Level 2: Police response. Six researchers were approached by police or security officers, and while they were able to peaceably resolve the calls, police shootings are a real concern in the United States and elsewhere. Researchers addressed these situations by showing proof that they had permission to be on the property (signed letter, email, etc.) and explaining their research when law enforcement or private security arrived.

For example, one author was approached by security officers employed by one of the property owners when an employee called in a complaint. They were permitted to resume work after the security officers examined their documentation and consulted internal records; however, after this incident they had to renegotiate access and email formal requests prior to each visit. They also changed to more professional attire and appearance afterwards.

Level 3: Direct threats. Three researchers encountered direct threats to their safety. In this situation, we advise moving to safety, and considering a call to 911 or your local equivalent if warranted and you feel safe doing so. Strongly consider dropping the site from your study—no data are worth your safety.

Prepare for stressful situations: Researchers should prepare for both stressful situations and routine questions, with safety as the most important objective. For stressful situations (Levels 2 and 3) and situations that could escalate (Level 1), the authors and other researchers converged on several approaches to avoid or de-escalate, which aligned with police officer suggestions. These include:

1. Have a way to prove that you have permission to be on the property—written documentation is best, but if that is not possible a phone number for the owner;
2. Carry photo identification that shows who you are and any institution you belong to;
3. If you are not the project PI, have the PI's and property owner's contact information on hand;
4. Use an institutional vehicle or place a placard with a phone number on your dashboard;
5. If the police are called, keep your hands visible; and

6. Consider giving your nonemergency dispatch a call to give them a heads up about who you are, where you are working, and what you are doing.

Prepare for routine questions: Addressing routine questions (Level 0) in a concise and informative way requires practice, and these interactions can help develop science communication skills. Though generally short answers are sufficient, not everyone is adept at asking questions. Pay attention to how people respond to your answers to common yet vague questions like 'What are you doing?' to help you refine the balance between brevity and enough detail. Multiple researchers reported that people asked, 'Why did you pick this property?' and needed to explain probability sampling or their sampling method in a way laypeople understand. People may also volunteer information about the property and its history that is valuable to your research. Consider carrying business cards and a straightforward informational handout to give to people who are curious about your research. For more interruption-sensitive methods like bird counts, consider having a sign or placard that explains what you are doing and asks people not to disturb you. Having a research partner in the field is very useful for these situations.

Sometimes people go beyond asking questions—for residential properties, nine researchers reported that some residents wanted to get involved in the science and help collect data, or that they wanted their children involved and would send them out to help. Consider what you will do if the situation arises; if you feel comfortable this can be a great way to expose children and lifelong learners to science.

Depending on your research context, it may help to dress to communicate intent (high visibility clothing, clipboard, obvious research equipment, institution logo gear, hard hat) or to fit in (professional clothing, including nice hiking/field clothing). If you are comfortable doing so, consider consulting your local police community outreach officers to see if they have any local suggestions.

If you are overseeing students, be sure they are adequately prepared and supported during fieldwork. Supervisors, principal investigators and senior students should steward a culture of respectful behavior, raise awareness and adopt or make students aware of independent reporting and enforcement mechanisms (Clancy et al. 2014). Creating lab safety protocols is a good first step.

Should I engage with property owners poststudy?

The authors believe that researchers should plan from the start of their projects to share the knowledge gained (Israel et al. 1998; Kramer 2016). Fifteen researchers indicated that they had or were planning to share information with property owners, while nine indicated that they did not and were not planning to for various reasons including time and monetary cost. Sharing knowledge shows property managers/owners that they are part of a larger project and demonstrates the impact their participation had. Many participants will also be interested specifically in the information gathered from their property.

Communicating results can take many forms, including publishing research highlights in neighborhood or industry newspapers or blog posts, distributing copies of published papers and providing summaries of what was found on each site with or without comparisons to other sites (with identifying information removed). Publicly accessible options like newspapers, blog posts, radio and television appearances, and public talks are important when you cannot follow up in person due to privacy

concerns or not collecting contact information. Holding industry and public workshops provides opportunities for dialogue, and libraries and community centers can make great partners.

When presenting results, consider the property owner perspective. First, property owners may be upset if you did not find something such as a species of interest on their property. In these cases, emphasize how important their property was for the research, and deemphasize that they did not have what you were looking for. Second, people like to see themselves and their neighborhoods reflected in the research. Consider presenting a ‘how X is your neighborhood?’ section, explain what X means for their industry/neighborhood and shows how their involvement made a difference. Third, consider presenting information in different but complimentary ways so it is more accessible. Most importantly, if you say you are going to provide results, be sure to follow through on your word, although you may need to warn people how long it will take.

At the very least, be sure to always thank participants in your studies; your research would not be possible without access to their property. In addition to thanking their participants, researchers have expressed gratitude by sending personalized letters, small gifts (e.g. plants for residential gardens, souvenirs from their institution) and acknowledging property owners in any resultant presentations or published papers.

Conclusion

Urban ecosystems contain complex mosaics of green space governed by multiple stakeholders (Aronson et al. 2017). Due to ecological differences among these green space types, private property research is crucial to our understanding of urban ecosystems. However, little formal guidance for new researchers is available in field protocols or the ecological literature. Early career scientists are thus frequently unprepared for, or wary of, working on private property. Key questions and challenges include managing access to a sufficiently large sample of study sites, contacting multiple parties to gain approval, and respectfully and safely communicating with property owners and managers.

We present practical advice from experienced researchers to help guide researchers considering working on urban private property for the first time (Box 1). Overall, researchers reported that their research design and sampling designs were influenced by the need to work with private property owners, reported success using multiple methods to recruit property owners though recognized the potential for bias, emphasized practicing good field safety and preparing for both routine and stressful in-person encounters, and found that communicating honestly and respectfully with property owners for the duration of the research was important to their success, particularly for multi-visit and multi-year studies.

We hope to reduce conflict between property owners and researchers and provide foundational knowledge and tools to new private property researchers balancing scientific merit, safety and respect to property owners. We encourage ecologists to think more holistically about their research approach, and how it impacts people. This may include implementing methods more commonly practiced in the social sciences, including ethics training and community-based participatory research.

Increased research on private property will allow researchers to ask questions addressing diverse land uses and management approaches and examine a broader range of organisms and ecosystem processes. Landscape scale studies can also facilitate cross-city comparisons within and among biomes and allow for multi-visit and multi-year approaches to examine

seasonal and yearly trends. Expanding the types of study sites included in empirical urban ecology research will also facilitate studies that address potential biases in study design. For example, how do response rates to access requests differ across land use type, demographic status, environmental awareness and locale? Are certain types of studies (organisms, methods used) performed more on one land use than others, and how does this shape our theory of urban ecology? Sociologists and medical researchers have quantified differences in response rates, and ecologists should also (e.g. Phillips, Reddy, and Durning 2016).

Given the rate at which urban land use is expanding, and the prevalence of private property among urban green space, further research and collaboration among ecologists and private property owners is necessary to improve our understanding and management of urban ecosystems. We hope that our suggestions will help guide the next generation of urban ecologists to take up this challenge.

Box 1: Checklist for conducting urban ecology research on private property.

Before data collection

- Be safe, respectful and ethical
 - Scout potential research areas first or consult local colleagues or residents.
 - Create safety protocols tailored to your context: personal, institutional, research objectives and site/neighborhood. Plan to work in pairs/groups when possible. Make sure someone knows when and where you are sampling every day.
 - Contact property owners in a safe and respectful way. In-person requests are faster but may be riskier; mailed requests are slower with higher nonresponse rates. Ensure the person granting access has authority to do so.
 - Photos, conceptual diagrams and videos are great tools to explain your research to potential participants. The easier these are to understand, the better. Make sure that you give property owners enough information about your project. Treat it as a public engagement activity to explain the importance of your research.
 - There should never be a single property you must have—if that person says no, you can't convince them. Thank them for their time and move on.
 - Consider property owner perceptions when developing research questions and methods. Ensure property owners understand and are comfortable with methods. If not, adjust accordingly (e.g. revise methods, drop site).
 - Ensure you comply with your institution's human and animal subject requirements.
 - If possible, consider adopting community centric approaches from public health and the social sciences, e.g. community-based participatory research.
- Expect—and plan for—the unexpected
 - Start looking for sites early. Make sure that your initial sampling design is robust; rejections and nonresponses will occur when contacting property owners, data can be lost due to crows/vandals/etc., and sites may drop out over time.
 - Have a plan in place for unanticipated site changes (e.g. construction, landscaping, tree removal).
 - Conduct a pilot study if feasible. Not all field methods work well in urban settings!

During data collection

- Be respectful (and realistic) with your scheduling
 - Treat the property owner's time and property with respect.
 - Clearly communicate your sampling schedule and activities with property owners and avoid rescheduling if possible. Follow any property-specific rules to which you have agreed.
 - Plan site visits to balance urban commuting time, methodological requirements and property owner preferences. Try to avoid sampling bias caused by visiting sites at specific times, e.g. site × time interaction.
 - Budget time for passersby, tenants or neighbors to talk to you. Remember that each conversation is an investment in the site, a source of new information and a valuable opportunity for public outreach. However, balance being polite with completing your work.
 - Consider having a script or pamphlet ready for people who approach you.
- Safety first!
 - Trust your gut. Be prepared to move or drop sites in unsafe situations.
 - Have a plan for handling any illegal activity you come across (e.g. trespassing, drugs).
 - Dress professionally, but appropriately for the context in which you're working.
 - Use an official vehicle if possible (or, place your institutional name and contact info on the dashboard).
 - Be prepared to prove you belong (carry ID, a letter describing your work and permission to be on the property).
 - If appropriate, contact the local police precinct(s) where you will be working to let them know who you are, where you will be, who has authorized you to be there and contact numbers.
- Think ahead
 - Don't slack on field season prep because you're in the city. Plan for any critical needs (food, water, bathrooms, equipment), weather, insect pests and terrain.
 - For multi-year studies, contact property owners well in advance of a new field season. Build in time to replace study sites or build up relationships with the new property owners if a property was sold.
 - Don't underestimate the time and logistical effort it will take to schedule appointments with property owners.

After research

- Follow up
 - Make results available to property owners in an accessible form. Although not everyone will be interested, outreach is an important part of giving back to property owners, particularly if policy decisions might be made based on your results.
 - Plan to keep in contact with property owners, particularly if you anticipate future use of sites (e.g. mailing lists or social media can be effective).
 - Don't forget to say thank you!
 - Budget time and money for outreach/dissemination of results.

Acknowledgments

Our sincere gratitude to the ecologists who spoke with us about private property research, the public health

researchers and police officers who shared their expertise, the participants in our 2016 Ecological Society of America workshop and 2017 poster session, and all reviewers of this manuscript.

Data availability

Data are not available online to comply with IRB approval granted by University of Washington Human Subjects Division.

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