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Parcel Management and Perceived Ecosystem Services and Disservices in the Exurbs of a Midwestern County in the United States

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Abstract: Exurban development is a prominent land use in the United States of America, particularly in the Midwest, where much of it occurs on farmland and remnant woodlands. While exurbanization may affect ecosystem services, its impact could be modulated by management decisions made by residents. We aimed to uncover how exurban residents in a midwestern county perceived ecosystem services and disservices provided by their property based on 26 semi-structured interviews of landowners on parcels between 1 and 20 acres with a pond in unincorporated areas. We found the ecosystem services people associated most with their land are classified as cultural services (dominated by recreation services), while the most common mentioned disservices were classified as regulating disservices. Many ecosystem services that would be categorized as supporting or regulating services were not mentioned by interviewees, including microclimate stabilization, carbon sequestration, disease regulation, and maintenance of genetic diversity. Residents spent an average of 1.4 h/acre each week managing their properties. However, as parcel size and forest cover increased, the residents reported managing less surface area. Our study suggested that residents cultivate landscape features that directly benefit them and view many of the services that benefit regional biodiversity and ecosystem processes as disservices, which, to rectify, may require coordinated landscape-level management or local policies/incentives.

Keywords: peri-urban; human–environment interaction; urban ecosystems; yard decisions; small ponds; coupled natural–human systems; rural sprawl; exurban; exurbs; exurbia

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Citation: Davis, A.Y.; Freund, A.; Dumyahn, S.L.; Mendoza, R.; Muniz Torres, A.; Boone, M.D. Parcel Management and Perceived Ecosystem Services and Disservices in the Exurbs of a Midwestern County in the United States. *Land* **2021**, *10*, 448. https://doi.org/10.3390/land10050448

Academic Editors: María Fe Schmitz, Cristina Herrero-Jáuregui and Cecilia Arnaiz-Schmitz

Received: 15 March 2021
Accepted: 21 April 2021
Published: 23 April 2021

1. Introduction

Exurban land use is characterized by large parcels of land located at the rural–suburban interface. Outside the United States of America (USA), exurbanization is often referred to as peri-urban development and is a worldwide phenomenon that co-occurs with urbanization (see for example, [1] in Europe, [2,3] in Ghana, [4] in India, and [5] in Bangladesh). According to Theobald [6], in 2006, approximately 9.3% of the land area of the lower 48 states in the USA was classified as exurban development [7], with a nearly fivefold increase in the area devoted to exurban land use from 1950 to 2000 [8]. Exurbs occur predominately in the agricultural regions of the midwestern USA [9], but they also occur near "leisure" locations, such as lakes and wooded areas [7,10]. In Ohio (the study area), roughly 30% of the population lives in exurban areas, which accounts for 3.7 million people out of a population of 11.6 million in 2014 [11,12]. In general, the land covers associated with exurban lands include tree cover, lawn, natural open areas, impervious surfaces and structures, water, and wetlands, as well as croplands [13]. It is difficult to generalize about the aggregate effects of exurban land use because land cover composition and configuration change over time [13]. Yet, the types of land covers present, the modifications residents make to land covers, and the management decisions residents adopt are known to affect the ecosystem services these areas provide [14], which could have large impacts on local and regional maintenance of ecosystem services.

Ecosystem services are defined as benefits that humans derive from the natural environment for free, such as food, shelter, biodiversity, pollination, water regulation, flood control, water filtration, and fuel sources [15]. Different land covers inherently provide different ecosystem services, and these ecosystem services can be derived from or even guide the development and management of exurban lands [7,16]. For example, exurban development can improve water quality [17]. However, less is known about the diversity of services these lands provide since many studies have focused on specific services such as water-related ones [17,18] or carbon storage [13,19–21]. Further, less is known about the potential disservices that exurban residents might perceive they receive from their land [22].

It is critical to establish which ecosystem services and disservices are present or identified by landowners on exurban lands before their value can be attributed [13,23]; yet, given that human–environment interactions govern this system, it is equally important to examine the management decisions made by exurbanites because those decisions can dictate the ecosystem services and disservices these lands provide. For instance, land management for lawn cover devoid of weeds can be the result of fertilizer and pesticide use that could impact the resource availability for pollinators or the environmental quality of nearby water bodies [17]. Moreover, an increased homogeneity of human-dominated landscapes toward lawns can intensify the effects of land use/cover change [13], which may affect the survival of native wildlife, the biodiversity of the surrounding ecoregion, and the possible ecosystem services these areas can offer [7]. However, land cover heterogeneity or homogeneity may be shaped by zoning and subdivision exemptions that influence both land use and minimum parcel size [24]. Parcel size in turn can influence how much of a parcel is actively managed or maintained by the resident(s), which can be referred to as a parcel's "zone of care" [20].

Many exurban parcels contain water features, such as permanent or intermittent streams, ponds, or wetlands, which have the potential to provide ecological benefits to both human (e.g., irrigation) and natural (e.g., regional water quality) systems [18,25]. Small water bodies (SWBs), water bodies smaller than 0.1 km^2, make up approximately 20% of the standing water in the USA [18,25]. One of the major functions of SWBs is to delay runoff from impervious surfaces and eroded surfaces and to catch sediment and chemicals from surface runoff before it enters larger bodies of water [18]. After the 1930s Dust Bowl in the USA, the Soil Conservation Service (predecessor to the National Resource Conservation Service) promoted building ponds on farms. Even today, landowners regularly ask their local Soil and Water Conservation District for assistance on where to build a pond on their property (personal communication with Butler Soil and Water Conservation District). In southwest Ohio, these SWBs are an important feature in the Ohio River watershed, where they serve as sediment traps and mitigate stormwater runoff [25]. Greenland-Smith et al. [26] found that ponds on farm properties provided additional ecosystem services, including irrigation and fire protection. The presence or addition of ponds on exurban parcels could result from intentional planning for ecological benefits or aesthetic desires of exurban residents [17]; the intended purpose may influence the management and, hence, the relative value of ecosystem services or ecological benefits.

The objective of the current study was to evaluate how much area residents manage (i.e., similar to the concept of "zone of care" in [20]) and how this varies with land cover, as well as to determine the residents' perceived ecosystem services or disservices on 1–20 acre exurban parcels with ponds in an important agricultural area of the USA.

2. Materials and Methods

2.1. Study Area

Butler County, Ohio (USA), is part of the Cincinnati Metropolitan Statistical Area (MSA), the largest MSA in Ohio (OH), and the 28th largest MSA in the USA [27] (Figure 1). The county contains three prominent towns: Hamilton (the county seat), Oxford, and Middletown. Each town is bordered predominantly by agricultural land interspersed with peri-urban development, which is referred to as the exurbs in the USA. Hamilton and Middletown are positioned along the Miami River. In the southeast, Butler County is crossed by I-75, the major highway between the cities of Cincinnati and Dayton, OH. Rural lands predominate in the northwestern portion of the county. Exurban growth pressures are particularly strong where the outskirts of the three towns overlap, making Butler County an ideal location to evaluate the impact of exurban lands in an agricultural region and providing a framework for comparison and further study.

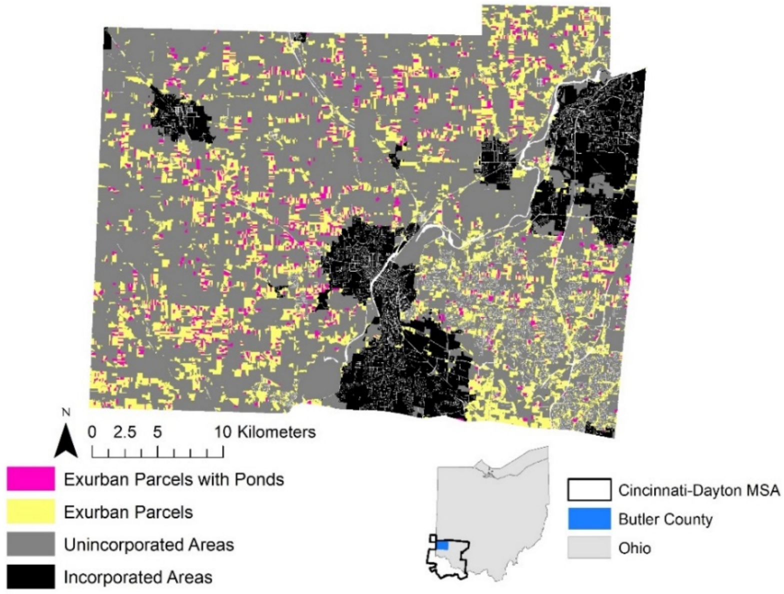


Figure 1. Study area map with inset showing the state of Ohio (USA) and the Cincinnati-Dayton Metropolitan Statistical Area (MSA), within which Butler County resides. We defined exurban parcels as those that were outside incorporated areas, between 1 and 20 acres, and which had a dwelling on them.

2.2. Identifying Exurban Parcels with Ponds across Land Cover Types

We obtained parcel data from the Butler County Auditor on 24 September 2014. Using ArcGIS 10.x and U.S. Census Bureau data that delineated incorporated areas in the county, we removed all parcels located within incorporated areas, i.e., Oxford, Middletown, and Hamilton. Exurban parcels were defined as those between 1 and 20 acres in size in unincorporated areas (Figure 1) to avoid working farms, and similar to other studies (e.g., 1–40 acres, Brown et al. (2005)). Parcels with the same owner that had a common boundary were merged into one parcel prior to selection. Of the 161,485 parcels in Butler County, 73,391 were in unincorporated areas, and 10,606 were between 1 and 20 acres with a dwelling (Supplementary Materials Table S1). From those 10,606 parcels, we selected parcels that contained a pond based on datasets from [18,28]. We updated this pond dataset using National Agriculture Imagery Program (NAIP) data downloaded from the United States Geological Survey's (USGS) Earth Explorer for Butler County OH, focusing on imagery taken between September and October 2013 that had four spectral bands (Red, Green, Blue, and Near Infrared at a 1 m by 1 m spatial resolution). These aerial photos were visually scanned for ponds at a scale of 1:4500 to ensure that even small ponds would be identified and digitized. Overall, 1538 exurban parcels (14.5%) completely contained at least one pond (Supplementary Materials Table S1).

We assigned a random number to each parcel with a pond and sorted parcels in ascending order. We asked the residents of the first 96 parcels for an interview (described below).

2.3. Land Cover Classification

We classified the four-band NAIP photos into six classes using supervised classification. These classes are Developed, Agriculture, Lawn and Pasture, Trees, Shadow (i.e., no data), and Water. We used a maximum likelihood classification approach in ENVI 5.2. The sieve tool was then applied to find isolated pixels that might have been misclassified. The tool examines each pixel's nine neighboring pixels; if three out of the eight closest neighbors match the center pixel, then it remained classified as its original value, and if not, the pixel was assigned the class that matched the majority of the eight closest pixels surrounding them.

To test the accuracy of the classification, we randomly selected 50 pixels from each class (excluding "no data" pixels). Each of the 250 points was assigned a random number so that the order with which the control points were visually classified using the NAIP data was random. We then aggregated for each parcel its proportional cover of each of the classes mentioned above.

2.4. Interviews

To conduct the semi-structured interviews, we employed a cold-knocking technique, in which the interviewer approached the residence and knocked on the front door without calling ahead [29]. If there was no response, we left a packet with contact information to set up a future interview. If there was a response, we would try to conduct the interview at that time or at a scheduled appointment time. The vehicle used by the interviewer displayed a clear indicator of affiliation with Miami University since we had placed a large magnet to both front car doors with a Miami University logo. Semi-structured interviews of willing residents were conducted. With permission from the resident, interviews were recorded to ensure ease of transcription and to maintain consistency.

The interview questions (Supplementary Materials Table S2) focused on land management strategies and the uses to which resident put their land and pond. The interviews were recorded and sent to a professional transcription service (Transcript Divas (New York, NY, USA)). The transcriptions were read and edited for accuracy and then coded using NVivo 11 (QSR International (Doncaster, Australia), 2015). A codebook defining and describing management and maintenance actions, as well as ecosystem services and disservices was developed to improve the coding consistency. Two coders systematically read through each interview twice and identified recurring themes regarding ecosystem services, disservices, as well as land and pond management practices. We followed the Millennium Ecosystem Assessment's definitions of ecosystem services [30]. AYD and SLD checked the accuracy of the coding.

Part of the interviews involved showing residents a printed map of the parcel on which they reside, with the property boundary and a high-resolution aerial photo of the area (dated 2013), as well as a scale bar and an indicator of direction. Residents were then asked to delineate which parts of the parcels were left unmanaged and, for areas they did manage, what steps were taken to do so. We georeferenced the marked-up maps, digitized the boundaries of the managed/unmanaged zones, and calculated the percent of the parcel that was described as "managed" by the resident. We did not verify these estimates with field data, which precluded defining a zone of care sensu Nassauer et al. [20].

2.5. Statistical Analysis

Using generalized additive models (GAMs, i.e., semiparametric regressions), we examined the relationship between the proportion of the parcel residents reported they managed and the proportion of the parcel in forest cover. We also examined whether the self-reported time spent managing the property per acre (in summer) was associated with the proportion of the parcel in forest cover. We initially used linear regression models to evaluate these relationships, but the residuals exhibited both nonnormality and heteroskedasticity that we could not remove using conventional transformations. Additionally, since GAMs fit smoothing functions instead of linear responses between the dependent and independent variables, GAMs are less sensitive than generalized linear models when one or more points strongly affect the outcome (i.e., when = outliers are present, as in our dataset [31]). To fit the GAMs, we used a Gaussian distribution with an identify-link function, when the response variable was continuous, and a beta distribution with a logit link function, when the response variable was the proportion of the parcel managed. Lastly, we examined spearman correlations between the self-reported time spent managing the property and the size of the parcel, as well as the size of the managed area(s). We used mgcv [32], foreign, and ggplot2 [33] packages in R version 3.3.2 (R Core Team 2016).

3. Results

Exurban land use consisted of approximately 15.5% of the total land in this county. The most abundant parcel size was 1 acre (Figure 2). Ponds were most commonly found on 5 acre parcels. Our overall response rate is 27%, with 96 individuals approached about conducting an interview.

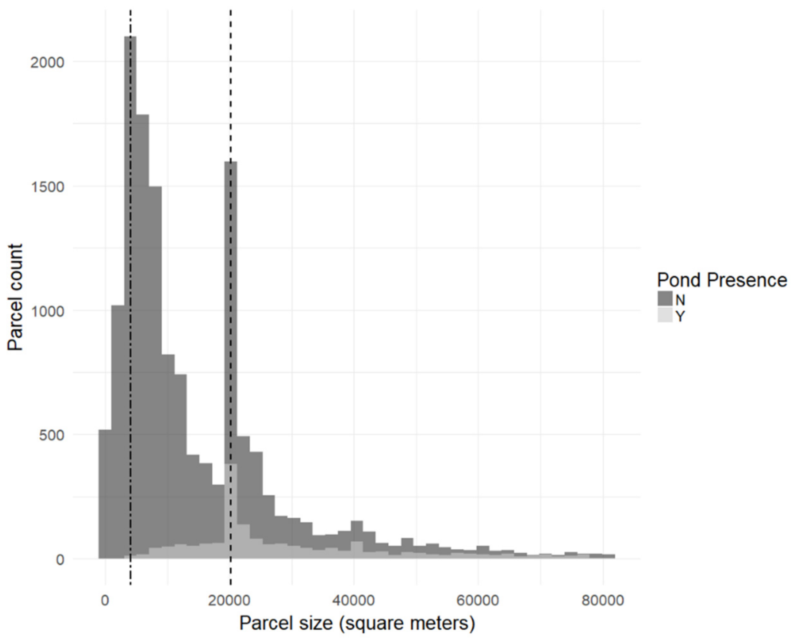


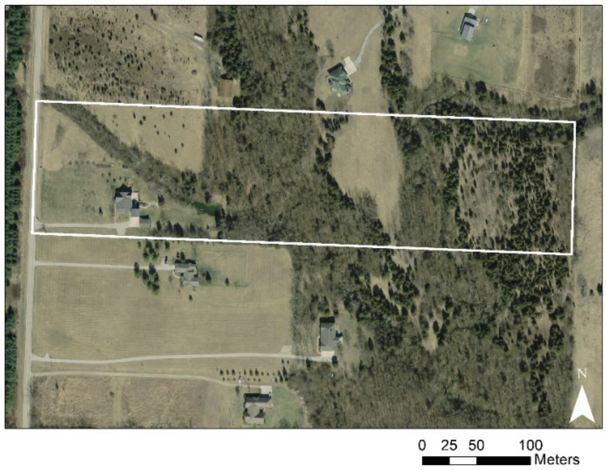
Figure 2. Exurban parcel size frequency in the study area with and without ponds. The dashed lines represent 1 acre and 5 acre parcels.

3.1. Land Cover Classification

The 2013 land cover classification resulted in an overall accuracy of 78%, with a kappa coefficient of 0.73. Since the kappa coefficient approaches one, the classification is considered more accurate. The pasture and grass classes had to be combined into one because with the four-band imagery, we were unable to reliability distinguish the two land covers.

Land covers on the exurban parcels consisted of 8.8% developed, 1.1% water, 42.1% forest, 9.1% agricultural, and 39.0% pasture/grass. In contrast, the land cover proportions for the portions of the county not in exurbs totaled 10.7% developed, 2.0% water, 34.5% forest, 25.9% agricultural, and 27.1% pasture/grass. Similarly, the land cover proportions for the entire county were 10.6% developed, 1.8% water, 36.1% forest, 22.0% agricultural, and 29.6% pasture/grass. The proportion of each parcel in the different cover types varied greatly especially in terms of forest cover versus pasture/grass cover (e.g., Figure 3).

(**a**)



(**b**)

(**c**)

Figure 3. Examples of parcels in our study area with increasing amounts of forest cover from top to bottom (**a**–**c**). White outlines are parcel boundaries. Aerial photos are from the National Agriculture Imagery Program in 2013.

3.2. Management Approaches and Time Spent Managing Exurban Parcels

As the proportion of the parcel covered in forest increased, the proportion of the parcel reported as managed by the resident significantly decreased (Figure 4). The estimate for the intercept, standard error, z-value, and p-value for the model are 0.9, 0.2, 4.8, and $p = 1.3 \times 10^{-6}$, respectively. The effective degrees of freedom for the smoothed proportion of forest term are 2.9 (chi-squared = 15.9, $p = 0.002$) with a scaling parameter of 1. The model explains 52.0% of the deviance and 42.2% of the variance. The Pearson correlation between observed values and fitted values was 0.73 ($p < 0.001$). Two of our respondents (7.7%) reported managing near the entirety of the parcel despite having more than 75% of it covered in trees (one of those parcels was ~15 acres and the other was ~2 acres). Generally, however, as the parcel size increased, residents reported managing less surface area of the parcel, and this was particularly true when forest encompassed more than 25% of the parcels (Figure 4 and Figure S1 in Supplementary Materials). For the properties that are dominated by lawn, the residents tended to actively manage most of the parcel (Supplementary Materials Figure S1). Model residuals had a reasonably normal distribution and did not exhibit heteroskedasticity (Supplementary Materials Figure S2).

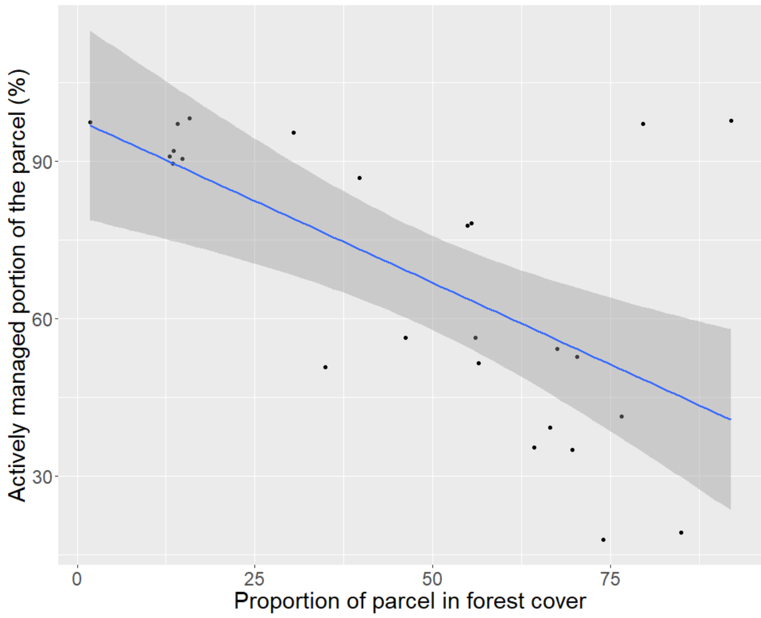


Figure 4. Relationship between proportion of forest cover on the parcel and the portion of the parcel that land occupants indicated they actively managed.

Interestingly, residents did not spend more or less time per acre managing parcels that were more forested. Indeed, that model was not significantly different than the null model ($F_{(16,20)} = 1.2$, df = 4, $p = 0.363$) with the residents spending 1.4 ± 1.6 (SD) hours/acre (median = 0.8 h per acre) managing the properties regardless of land cover. Furthermore, time spent managing a parcel and parcel size were not correlated (rho = 0.07, $p = 0.75$), nor was time spent managing the parcel and the size of the area managed (rho = -0.11, $p = 0.64$).

The most common management practices indicated by residents were mowing (mentioned by 73% of our respondents), invasive species management (62% of respondents), planting (trees, shrubs, and flowers; 54%), as well as using fertilizers (23%) and herbicides (35%). Additionally, 50% of respondents stated wanting to keep their management of the property chemical-free as a way to be more "environmentally friendly." To control pond algae, nine of those individuals mentioned using fish specifically to control algae. Overall, 46% of interviewees added dye to the pond to improve pond aesthetics and control algae, and 12% added a fountain to the pond. The residents viewed fountains, dyes, and fish as "natural" options according to resident statements.

During the interviews, 80% percent of respondents said they (or previous owners) had added grass carp or bluegill to their pond to control algae, which one noted was a recommendation of personnel at the local soil and water conservation district. Respondents indicated they believed fish addition was a better option than adding chemicals to their pond. Three interviewees (11.5% of all interviewees) recognized that the fish provide a pest regulation service by reducing mosquito populations and one interviewee indicated that fish eat frog tadpoles in the pond. Moreover, 10 interviewees (38.5%) brought up frogs, nine of them in a positive manner.

3.3. Residents' Perceptions of Ecosystem Services and Disservices

The ecosystem services people associated most with their land are cultural services (dominated by recreation services), followed by provisioning, regulating, and biodiversity services (Figure 5). Supporting services (i.e., nutrient cycling, photosynthesis) were not acknowledged by residents except as a perceived disservice (once; Figure 6b). The most commonly mentioned provisioning service was using the land to grow food in the form of vegetable gardens, crops, or orchards (Figure 6a). The presence of wildlife (especially birds, frogs and fish), i.e., the biodiversity ecosystem service, was mentioned by over half of our interviewees, especially with regard to the pond (46.2% of all interviews). The pond was primarily used for recreation, including fishing, nature watching, swimming, ice-skating, and boating (Figures 5 and 7); additionally, the pond was used as a gathering place, a place to be inspired by nature, and a place where they could experience "peace and quiet" (i.e., aesthetic services). Regulating services of the pond, especially flood regulation and pest control were brought up by 38.5% and 34.6% of residents, respectively (Figure 6a). Nearly 20% of all respondents used the pond for water provisioning (eight respondents use it as a water source for cattle and horses, while two used it for irrigation and two used it in the house for everything except drinking water). Many ecosystem services were never mentioned by any of our interviewees including stabilization of microclimate, carbon sequestration, disease regulation, medicinal resources, and maintenance of genetic diversity.

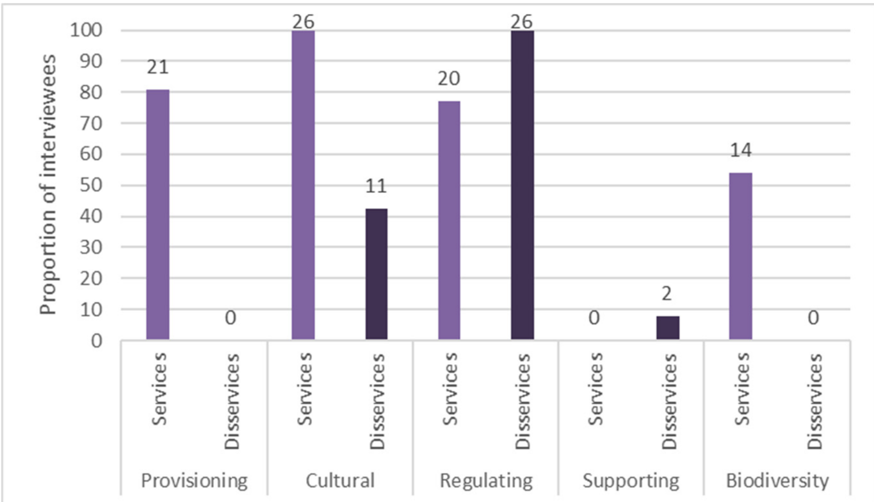
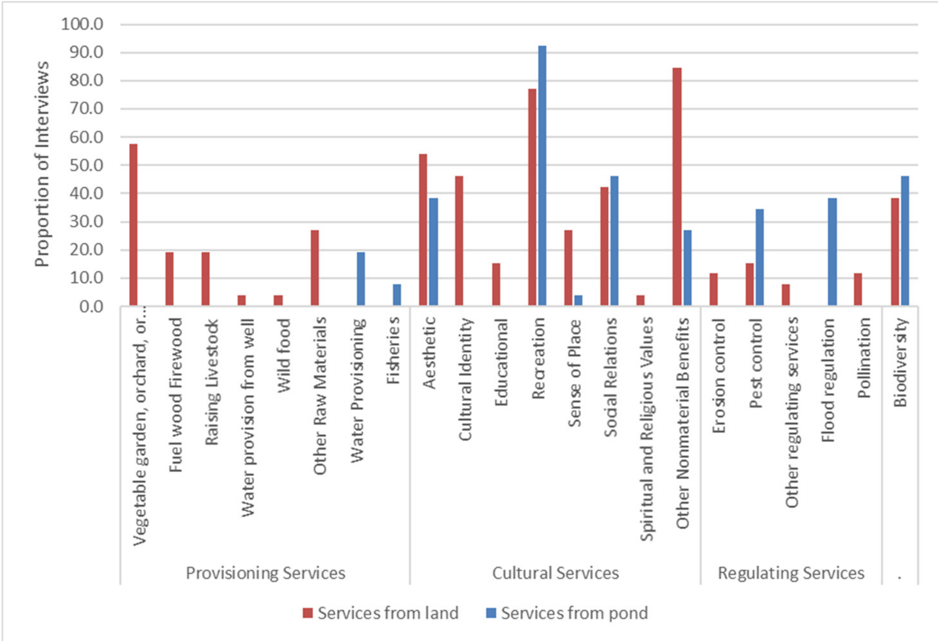


Figure 5. Proportion of interviews in which broad categories of ecosystem services and disservices were mentioned.



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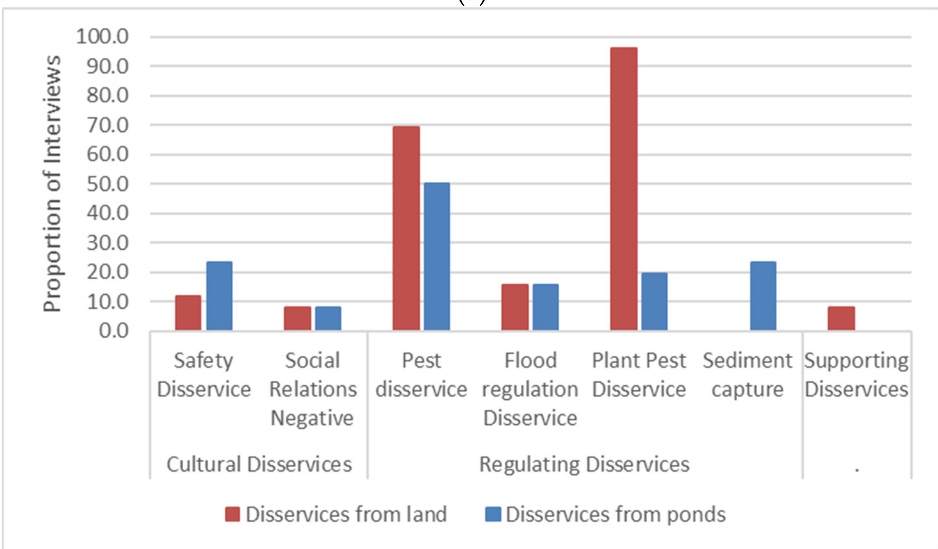

(**b**)

Figure 6. Proportion of interviews that we classified as mentioning (**a**—top) ecosystem services and (**b**—bottom) ecosystem disservices. We did not explicitly ask interviewees about each ecosystem service or disservice, but their responses to the interview questions indicated many ecosystem services and were classified accordingly. Therefore, these results should be interpreted as the ecosystem services and disservices that were most important to the interviewees. The total number of interviews was 26.

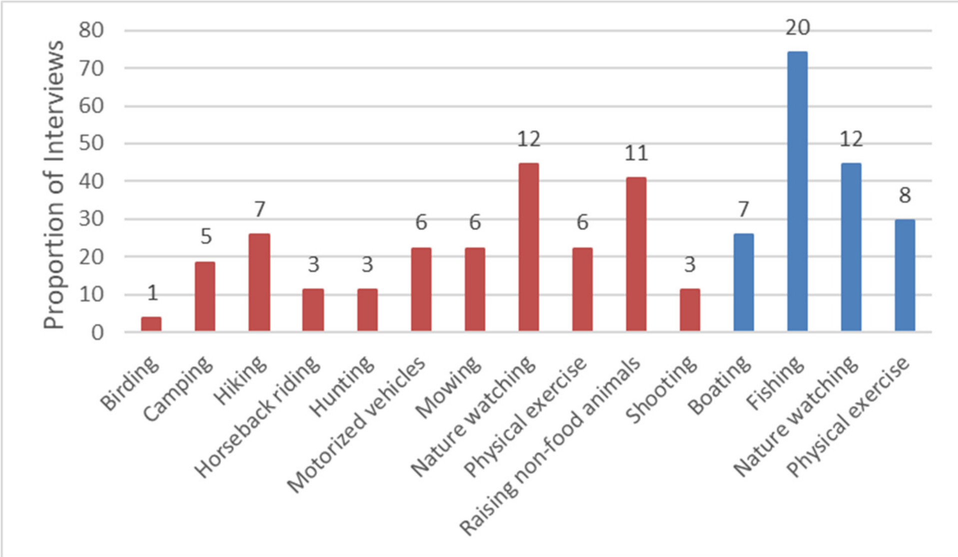

Figure 7. Proportion of interviewees who mentioned each recreational service provided by their land (in red) and their pond (in blue). The number of interviewees who mentioned each recreation type is placed above the bar. The total number of interviews is 26.

Although residents overwhelmingly saw their land and associated pond in a positive light, they also mentioned a number of ecosystem disservices, in particular regulating disservices. More than 90% of respondents acknowledged struggling to manage invasive species on land, especially amur honeysuckle, (*Lonicera maackii*; Figure 6b). Another source of frequent lament among landowners was the presence of perceived pests. Overall, 70% of residents mentioned ticks (Family *Ixodidae*), chiggers (Family *Trombiculidae*), or tree deaths from the emerald ash borer (*Agrilus planipennis)*, in particular, as well as raccoons (*Procyon lotor*), foxes (*Vulpes vulpes* or *Urocyon cinereoragenteus*), and coyotes (*Canis latrans*), which killed their chickens. Over 20% of interviewees indicated that their pond acted as a sediment trap, which they considered a nuisance because they had to have it re-dug when it became too shallow to be used for many recreational activities. The main disservice indicated about the ponds was algal growth (mentioned in a negative way by 50% of the residents). The cultural disservices most often commented on with regard to the pond were worries of safety (especially children and pets) and concerns about uninvited people stopping by to fish (Figure 6b). No one indicated supporting, provisioning, or biodiversity disservices from their pond.

4. Discussion

Exurban growth, when occurring in agricultural areas, has the potential to restore natural habitat and provide many ecosystem services. Whether or not the outcomes are positive will hinge on the types and extent of land covers on these large residential parcels and the management decisions that individual landowners make decisions that depend upon landowners' perceptions of ecosystem services and disservices, as well as their willingness to restore habitat to a more natural state, to manage for invasive species and to foster native flora and fauna. In our study, we found extensive exurban lands in a county on the outskirts of two midsized midwestern cities (Cincinnati and Dayton in Ohio). Across these exurban properties, we documented large variation in land covers and their extent, as well as management practices, highlighting the possibility for this land use to increase habitat heterogeneity on the landscape for native species. Our results shed light on how landowners view the ecological services and disservices of these habitats and highlight areas where greater efforts may be needed to maximize the ecological benefits of these lands in agricultural regions.

4.1. Exurban Lands and Their Management

While species declines and extinctions are globally on the rise, solutions such as E.O. Wilson's Half-Earth Project have suggested protecting half of the terrestrial lands for wildlife and using the other half for humans [34]. Such a solution may seem out of reach until one considers the contribution that small habitat patches make to biodiversity [35–37] and whether or not these fragments can assist in the maintenance of the ecosystem, species, and genetic diversity for at least some portion of our native flora and fauna. In our study area, the exurbs (classified here as 1–20 acre parcels situated outside incorporated areas with a dwelling) represented ~16% of the area and had a range of land cover types, with many containing at least some portion of forest (the native land cover of this area). Exurban parcels consisted of ~41% forest cover within the study area, compared with ~34% forest on the remaining land, indicating that exurban parcels are increasing (or maintaining) the historic forest land cover, which sets the stage for supporting native species and the ecosystem services associated with tree cover [38]. Furthermore, approximately 14.5% of the exurban properties had human-made ponds or impoundments, which create permanent aquatic habitats in areas that have been historically tiled to disrupt natural hydrological cycles and diminish habitat for wetland-associated species [25,39]; therefore, exurban lands also restore aquatic habitats to the landscape. The ecological value of the exurbs, however, will depend upon the decisions and values held by the people who live on them.

In terms of physical management of their properties, the residents with predominantly lawn- or pasture-covered parcels managed almost the entirety of the parcel, while the residents with more than 25% of their parcel in forest cover tended to leave the forested part unmanaged. Other studies uncovered different patterns. Zhou et al. [40] reported that for large parcels with lawns in two counties in Maryland, only the area around the house was intensively managed with the other areas left as tall grass (note that the surface area of "large" parcels was not specified). Visscher et al. [19] found that the size of the area intensively maintained by a resident increased with parcel size only up to a point (1 acre in Michigan, USA) and that, for example, residents did not fertilize beyond that managed area. Nassauer et al. [20] uncovered similar patterns for parcels in Michigan. Evaluating dominant land covers and assessing management intensity may help explain these seemingly differing patterns; more research on this topic is needed. Regardless, while managed areas may offer beneficial habitat for some species (e.g., birds, pollinators, small mammals in lawns and pastures [41–43]), the unmanaged portions of the landscape offer the potential to return the landscape to historic habitats and the matrix of the individual patches influences their biological potential [35,44,45].

4.2. Ecosystem Services and Disservices

Human life is sustained by the ecosystem services provided by natural systems so that the value of the services is directly related to the functional condition of the ecosystems [46]. Decisions made by landowners for their personal benefit and/or for their community at large will shape the characteristics of the landscape and will impact the integrity of the ecosystems within. Landowners interviewed in our study seemed, understandably, largely focused on managing their parcels toward their personal benefit with concerns about a wider landscape outside of their scope of interest. The interviewees particularly valued the cultural and provisioning ecosystem services that provided direct and concrete benefits. These services led to fishing or stocking fish in ponds, planting family gardens and keeping domestic animals, and engaging in recreational activities on the land and in the pond—services that benefited the individual landowner but may have limited ecological value. If people living in the exurbs have all (or most) of their recreation needs met on their land and their pond, they may be less inclined to fund existing public parks or support the creation of new ones. One respondent stated during their interview, "Sometimes I just want to go home and fish, not go to a lake or river, because then I have to deal with people and more regulation." If this sentiment is widespread, especially when exurban growth occurs around state and national parks, the social value given to these public goods could diminish [47].

The provisioning and cultural services most valued by landowners also coincided with management activities for reducing invasive species; creating welcoming habitats for wildlife via the pond, natural habitats, and birdhouses/feeders; and making decisions to limit chemical applications to protect both humans and wildlife. Given the landowners' overwhelming appreciation of wildlife on their land and in their ponds, as well as the desire of many to make environmentally friendly management decisions, these areas may proffer valuable habitat to species and provide untapped opportunities to cultivate knowledge about the role individual management strategies could provide to local processes that are beneficial to the coupled human–natural system at large. However, because the exurbs tend to occur near natural features such as lakes and federal/state parks [10], exurban development could alter land cover by increasing lawn cover, which provides few ecosystem services and increased disservices [48], thereby negatively impacting natural areas. In an agricultural setting, however, the exurbs may restore less intensive and more natural systems to the landscape, increasing habitat heterogeneity, which would be beneficial to local biodiversity [49].

In contrast, it was striking that the ecosystem services that indirectly benefit individual landowners—regulating and supporting services—and that are important at broader geographical scales (i.e., beyond individual parcels) were either not mentioned or were mentioned as disservices as often as they were mentioned as ecosystem services. While interview questions were open ended, they allowed residents to respond to the aspects of their property that they most valued; interview responses suggested that the significance of their individual property management to the wider community was not at the forefront of their minds. Ecosystem services act at different scales [50,51]. When these services directly benefit landowners, residents may actively support them without incentives; however, processes acting at the landscape level may require facilitation. For instance, regulating services such as flood control and carbon storage, which arguably offer the greatest ecological benefits, may require local or regional policies and incentives if they are to be sustained indefinitely. Comparably, Zhang et al. [52] found that ecosystem services and disservices operated at different scales in agricultural ecosystems: provisioning services provided at the field and farm scale gave individual farmers incentive to manage services such as soil retention, pollination, and pest control, yet maintaining ecological complexity to increase natural enemies and pollinators (for instance) reduced acreage farmed and could be costly to individual farmers (although see [53]). In these cases, policies that provide incentives for farmers to maintain services that benefit the larger community are often employed [52]. Similarly, because exurbanites may not actively manage their properties in ways that could have important benefits at the landscape level, policies or incentives to do so could increase the value of these lands to the landscape at large.

Approximately 14.5% of the exurban parcels in the study area had ponds. These ponds were all constructed by previous or current landowners, and serve an important role in reducing sediment (and hence nutrient) input into streams [18,25] and in providing critical habitat for aquatic species experiencing habitat loss [54]. Interestingly, the ecosystem service of "sediment capture" was viewed as a disservice by more than 20% of residents, likely because this service was in opposition to many of the listed reasons for valuing the ponds, especially recreation and aesthetics. Given the periodic expense associated with removing sediment from ponds and the consequences of increased sedimentation (e.g., algal blooms, excessive aquatic plants, fish kills), this landscape-level ecosystem service may be burdensome to individuals who mainly view the ponds as sites for cultural services (at the parcel scale). Policies or incentives that help alleviate the perceived disservices, such as free sediment removal or payment for ecosystem service schemes, would assist in maintaining the regulating services of ponds in the agricultural Midwest.

4.3. Potential for Biodiversity

Although exurban land use has been overwhelmingly viewed as having negative impacts on native flora and fauna in parts of the USA (e.g., west [7,55,56]; northeast [57]), their ecological value may change across systems, particularly when exurban development promotes natural habitats or processes [56]. Biodiversity in agricultural areas that were historically either grassland or forest could benefit from exurban growth when some of the land converts to native land cover. Furthermore, the created pond habitats on these sites have been found to be more similar to protected natural habitat than to managed areas (e.g., farms, golf courses, city parks; Boone, unpublished data) and are used by local species (e.g., amphibians [58]). Our study found that the exurbs were, in part, restoring or maintaining native habitat types to parts of the landscape, although the ecological quality and benefits these lands proffer need to be investigated.

Although exurban lands and the more natural habitats on them may be patchy in nature, research has demonstrated the value of small habitat patches in maintaining species diversity [35–37]. Many landowners noted their appreciation for wildlife on their properties and actively worked to attract wildlife to their land and ponds. This conforms with Davis et al. [59], who found that the desire to plant pollinator gardens in the Midwest was strong even though the total area that individuals were ready to immediately convert to pollinator beneficial plants was modest and species dependent. Exurban land also generate human–wildlife conflicts (e.g., [57]), but they may offer small patches of paradise for species whose habitat has been subsumed by development or agricultural fields, and these small patches can maintain the species richness of the region at the landscape level [36,49]. For instance, the creation of ponds is often readily colonized by species such as amphibians and insects with complex life cycles, which may allow for their persistence and recovery on a landscape that has experienced wetland loss [54] and the creation of which effectively restores many of their ecological services to the system [60].

4.4. Limitations and Future Research Needs

Ecosystem services are a utilitarian concept that is highly anthropocentric. The "use" questions in the interview prompts were designed to elicit the interviewee to voluntarily bring up how the land and the pond benefit them and thus encourage them to specify the benefits they are receiving from their land and pond for free, i.e., ecosystem services. We did not use the term ecosystem service (or disservice) explicitly with our interviewees because they are not well known or understood by the general public. Since interviewees were not asked about each ecosystem service individually, the fact that some ecosystem services were not mentioned by the respondent does not necessarily demonstrate lack of appreciation for those services. In the present study, we focused on the ecosystem services that were mentioned by the resident, i.e., those that tended to be both obvious and tangible to the landowners.

It may seem counterintuitive that exurbanites in this study managed significantly less of their properties' surface area if the parcel was primarily forested, yet there was no difference in the time per acre spent managing the properties. Residents may have a set amount of time they can devote to gardening and yard maintenance regardless of property size, and taking care of forest cover, especially if attempting to remove invasive species, is most likely more time intensive than mowing the same amount of land. This would of course affect the quality of the ecosystem services provided by these lands independent of land cover. We did not assess the quality of ecosystem services provided on these lands. This is a needed area of future research; one that should focus both on quantifying and assessing the quality of ecosystem services on exurban parcels with varying parcel sizes and land covers as well as across ecoregions.

5. Conclusions

Residents become land managers when they move to the exurbs; what these residents value and how they manage the land covers on their properties will have important implications for the ecosystem services that dominate at local and landscape scales. Land cover, however, also can influence the actions that residents take. We found that the predominant land cover of each property affected how much of the land exurbanites reported managing, with parcels that are dominated by forest cover left largely unmanaged. This, of course, affects the ecosystem benefits derived from these lands and associated ponds. Our research also revealed that individuals are managing their property in ways to harness the direct benefits of the provisioning, cultural, and regulatory ecological services that their land provides. Yet, they are also dealing with perceived ecosystem disservices, which can result from broader-scale processes. For instance, invasive exotic species such as amur honeysuckle and the emerald ash borer impact the ecological quality of these landscapes and demand greater management efforts, while at the same time diminishing the cultural services of the property. Other perceived disservices such as pond sedimentation are a result of the actions of both individual and surrounding landowners—again an issue of spatial scale—but the ponds are actually providing an ecological service by reducing the movement of sediments into streams and rivers. Policies that incentivize control of invasive species or compensate owners for ponds collecting sediments could help landowners balance the personal costs of disservices saddled on individuals to restore some ecological services to the local community. Since many landowners in our exurban landscape are managing their lands in ways that allow more natural systems to regenerate and because they value many of the ecosystem services the natural system offers, local biodiversity can benefit from the agglomeration of habitat patches on these residential land uses. The full potential of exurban lands, however, may only be realized with policies that incentivize the management practices that are perceived as disservices to the individuals but are actually services to the human and biological communities at large.

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/land10050448/s1, Table S1: Steps detailing the selection process for the parcels from which we drew the random sample, starting with all parcels in Butler County, Ohio (U.S.A.) as of 24 September 2014. Table S2: List of interview questions for semi-structured interviews. Figure S1: Relationship between parcel size (in acres), the size of the area the respondents reported managing on the maps of their parcels, and the proportion of the parcel that is in forest cover (displayed by the size of the circles). Figure S2: Residual plots for the generalized additive model predicting the proportion of the parcel that is managed (response) as a function of a smoothed proportion of the parcel that is in forest cover.

Author Contributions: Conceptualization, A.Y.D., M.D.B., and S.L.D.; methodology, all authors; formal analysis, A.Y.D.; investigation, all authors; data curation, A.F. and A.Y.D.; resources, A.Y.D. and M.D.B.; software, A.Y.D.; validation, A.Y.D., M.D.B., and S.L.D.; funding acquisition, A.Y.D. and M.D.B.; writing—original draft preparation., A.Y.D., A.F., and M.D.B.; writing—review and editing, A.Y.D. and M.D.B.; visualization, A.Y.D.; supervision, A.Y.D., M.D.B., and S.L.D.; project administration, A.Y.D. and M.D.B. All authors have read and agreed to the published version of the manuscript.

Funding: This research was partially supported by the NSF's REU Site at Miami University, "The Ecology of Human-Dominated Landscapes" (DBI-1460518), as well as Miami University's Undergraduate Summer Scholar Funds, and Dean and Honor's Scholar funds. We also wish to thank the Department of Geography and the Committee on Faculty Research at Miami University for providing the funds to support open access publishing of this article.

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board of Miami University (protocol reference number 02196e) on 16 June 2016.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data in this study are available on request from the corresponding author, except the interview transcripts, parcel data, and maps of the interviewees' properties in order to preserve the confidentiality of the study's human subjects.

Acknowledgments: We are especially grateful to Kimberly Medley for providing extensive feedback on earlier drafts of this manuscript. We also wish to thank the residents of Butler County (Ohio) who consented to participate in this project and took time out of their busy lives to show us around their properties. Lastly, thank you to Zoey Scancarello and Jessica Stoyko for their assistance in coding the interviews.

Conflicts of Interest: The authors declare no conflict of interest.

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