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Research Paper

Accessing blue spaces: Social and geographic factors structuring familiarity with, use of, and appreciation of urban waterways

Melissa Haeffner[a,*], Douglas Jackson-Smith[b], Martin Buchert[c], Jordan Risley[a]

[a] Utah State University, United States
[b] The Ohio State University, United States
[c] University of Utah, United States

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ABSTRACT

Are urban waterways amenities, and if so, are there inequities in household access? While urban waterways represent a potential site for access to nature within the urban environment, there have been few studies on the accessibility and interactions with water features in particular, what we refer to as "blue spaces." This study drew on a sample of households in Northern Utah living in neighborhoods with a nearby river or canal to ask if local waterways provide positive impacts to households and if proximity to them increased the likelihood of households spending time at them and being familiar with them. We used multivariate regression to demonstrate that socio-structural and accessibility characteristics shape patterns of familiarity and use, and mediate the impacts of blue space characteristics on households. We found evidence supporting the idea that urban waterways are positive amenities for neighborhood quality of life. We also found that the farther away a household lived from the blue space, the less likely they were to be aware of or use the amenity. Surprisingly, we also found that while high socio-economic status (SES) and white respondents generally lived further from points of access to urban waterways, they reported higher familiarity and were more likely to spend time at them than lower SES and nonwhite Hispanic households. Results suggest that future research and community engagement related to urban blue spaces should be attentive to how social structure and the characteristics of the built environment mediate access to these amenities.

1. Introduction

There is a growing literature showing how proximity to urban green space can produce improved health outcomes like reductions in obesity, diabetes and cardiovascular morbidity (Cutts, Darby, Boone, & Brewis, 2009; Ngom, Gosselin, Blais, & Rochette, 2016). Among urban planners interested in increasing access to public open and green spaces, early studies focused mainly on spatial separation (distance) as the key constraint to resident's ability to take advantage of these amenities. Technology advancements such as GIS and more widely available geospatial data facilitated access studies by providing easier ways to measure distance to urban amenities (Comber, Brunsdon, & Green, 2008; Heckert, 2013; La Rosa, 2014). A recent review of the access to green space literature has shown that focusing on proximity alone provides inconclusive results (Rigolon, 2016), and that variation in the size, configuration, and quality of parks and open spaces are as important as simple proximity in shaping patterns of familiarity (awareness and knowledge) and use of green spaces, and thus mediate the benefits they provide.

Urban green spaces are not limited to terrestrial parks and open areas, but also include urban waterways. The benefits provided by water features have been widely acknowledged, both as ecological services (e.g., carbon sequestration, oxygen production, noise reduction, microclimates, etc.) and as places that are used for recreation and social interaction (e.g., exercise, sport, etc.) (Kumar, 2010); (Kondolf & Pinto, 2016). In this paper, we use a multi-method approach to explore how local residents experience different types of urban blue space in a sample of neighborhoods in northern Utah. Our overarching research question is 'What factors explain variation in household familiarity, time spent, and interactions with urban blue space?'

2. What is blue space?

As blue spaces, we consider hydrographic features that can be waterbodies (e.g., estuaries, ice masses, lakes and ponds, playas, reservoirs, and swamps and marshes) or flowlines that make up a linear surface water drainage network (e.g., canals and ditches, coastlines, streams and rivers) (USGS, 2015). Streams, river banks, and riparian

* Corresponding author.
E-mail addresses: melissa.haeffner@usu.edu, melissahaeffner@hotmail.com (M. Haeffner).

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areas are sometimes included under the umbrella term "green space" along with urban parks, trails, and open spaces (Roy, Byrne, & Pickering, 2012; Wolch, Byrne, & Newell, 2014). However, urban water features have generally received much less attention from researchers than terrestrial green spaces, prompting a call for more exploration of the specific role and importance of "blue spaces" within urban environments (Gledhill & James, 2008). While the concept of blue spaces overlaps with green space, we argue that blue spaces provide different kinds of benefits to users. They are sensed in different ways, for example, running water has sonic qualities that can be used by urban planners to create relaxing soundscapes (Raimbault & Dubois, 2005: 355). People visit waterways for different recreational purposes, and they attract different kinds of wildlife (e.g., fish, ducks) than terrestrial spaces. While waterways also provide important environmental and economic benefits, we focus on social benefits in this study.

Urban blue spaces have yet to be thoroughly studied as either positive or negative amenities in this literature. On the one hand, ecologically healthy or restored waterways with public access opportunities can contribute to an aesthetically pleasing experience. On the other hand, unmonitored or poorly managed urban waterways can be sites of flooding risk, insect pests, pollution and/or waste disposal. Finally, even ecologically sound wetland systems can be perceived by humans as disamenities, due to the smells of anaerobic decomposition and the insect populations that thrive in them. In the sparse blue space literature that does exist, coastal waterways were shown to provide quality of life benefits, and residents most frequently visited waterways closest to where they lived (Cox, Johnstone, & Robinson, 2006). Another study explored distance to stormwater ponds in Florida, finding that economically stressed census block groups in the inner-city community tended to be located closer to stormwater ponds with less quality, diversity, and size (Wendel, Downs, & Mihelcic, 2011). Meanwhile, inland urban waterways such as rivers and canals remain understudied as neighborhood amenities with potential impacts on urban households. Two meta-analyses focusing on the impacts of blue space on mental health (Gascon et al., 2015) or long-term human health (Völker & Kistemann, 2011) found inadequate evidence due to the limited amount of empirical research on the topic.

2.1. Opportunities and barriers for accessing green and blue spaces

Following previous work (El-Geneidy & Levinson, 2006; Hansen, 1959), we define 'access' as the *opportunities for interaction with* and *ability to use* urban natural spaces. Many cities around the world have initiated urban greening projects such as Hangzhou's XiXi Wetlands in China (Wolch et al., 2014; Sang, Shu, Zhu, & Su, 2013). Yet a growing body of literature has found disparities in distance to such natural areas in cities in the United States (Dai, 2011; Gobster, 1998; Heckert, 2013; Heynen, Perkins, & Roy, 2006), Canada (Ngom, Gosselin, Blais, & Rochette, 2016), Denmark (Schipperijn et al., 2010), Israel (Omer & Or, 2005), and the United Kingdom (Comber et al., 2008), for example. In this paper, we look beyond measures of proximity to understand the full scope of access. Given the links between natural amenity access and human health, previous studies have argued that we should be concerned if access is distributed in ways that allow some social groups to benefit while preventing those same opportunities for others (Heynen et al., 2006; Perkins, Heynen, & Wilson, 2004). Access to public green space is increasingly recognized as an environmental justice issue (Wolch et al., 2014). Even aside from disparities in spatial distribution, racial and ethnic background can shape patterns of use of green space, because of different cultural preferences and because of real and perceived racial discrimination (Gobster, 2002).

Socioeconomic status (SES), such as income, educational attainment, and home ownership influence the decisions about what a household chooses to live near and what options are available to choose from. Studies in the USA have found that white residents and households with higher incomes, higher educational attainment, and higher homeownership rates tend to have access to a higher number of goods and services that make locations attractive (Crawford et al., 2008; Sister, Wolch, & Wilson, 2010; Zhou & Kim, 2013). Differential patterns of access may also reflect dynamics of the housing market across time. In a study of Montreal, Canada, Ngom, Gosselin, and Blais (2016) found evidence of a process by which rising housing values adjacent to urban green spaces have led to a process of "green gentrification."

Quality of amenities can be just as important than proximity. For example, Boone et al. (2009) found that although black residents in Baltimore, Maryland tended to live closer to parks in general, whites lived closer to parks that were bigger, less heavily trafficked, and potentially provided a more pleasant experience. Others have found a stronger correlation between the *size* of parks and access than the *number* of parks and access (Boone, Buckley, Grove, & Sister, 2009; Estabrooks, Lee, & Gyurcsik, 2003; Wen, Zhang, Harris, Holt, & Croft, 2013). Similar patterns might be expected with respect to access to blue spaces with varying qualities. River restoration is increasingly advocated as a strategy facilitating public access and use of urban waterways (Findlay & Taylor, 2006; Kondolf & Yang, 2008; Prior, 2016). Studies have found that urban homeowners will pay a premium for properties that allow them to live near both green spaces (Irwin, Jeanty, & Partridge, 2014; Nicholls, 2004) as well as urban riparian corridors (Netusil, 2006). At the same time, private ownership of properties adjacent to waterways can impede use by others if individuals have to trespass in order to access them.

The ability to spend time at an urban waterway can also be structured by household characteristics. Leisure scholars, for example, have long pointed out that social class can constrain access to recreational activities, in other words, the higher the household income, the more money householder members have to spend on gear, permits, and the like (Crawford, Jackson, & Godbey, 1991). In addition, the longer people live at their residence, the more time they have to learn about and explore their neighborhood, which can increase awareness and use of these amenities. While empirical tests of this idea are hard to find and provide contradictory clues (Beyer et al., 2014; Chen et al., 2015), others have specifically called for researchers to account for length of residence in studies of access to urban green space (Lackey & Kaczynski, 2009). Finally, household structure such as how many children under the age of 18 live in the household, might help predict whether or not households know about and seek out their local waterway. On the one hand, youth might be more apt to play along waterways. On the other hand, adults might find these places to be unsafe and discourage their children's use.

In this paper, we explore how individual and household characteristics (education, race/ethnic background, homeownership status, income, presence of children, and length of residence) are related to familiarity and use of urban blue spaces. Based on the literature, we expect that households whose residents who are white, have higher income, have more education, have children, and have resided longer in the neighborhood are more likely to be engaged with local blue spaces, but that these are mediated by proximity, levels of public access associated with the built environment, and qualities of blue spaces (e.g., waterway type and perceived amenity value). We further explore to what degree household features predict whether households are positively impacted by active (visiting and walking, playing) and passive (sensing sights and sounds, enjoying wildlife) interactions with their local blue spaces. Our study makes the following contributions to the literature. First, we pay particular attention to the role of adjacency, or parcels which directly abut urban waterways, which is often overlooked in the literature but privileges certain households over others in their likelihood of being familiar with and using the blue space. This method goes beyond the traditional ways of measuring access using linear measures of distance to the natural amenity. Second, we account for the character of the waterway (canal vs. river) and its perceived amenity value as factors that can alter the likelihood that a household reports familiarity with and spending time at their local waterway. A better understanding of the influences of both social and built structures on access to blue spaces can help urban planners and decision makers target their efforts to promote use of and familiarity with urban waterways and to maximize benefits to local residents and communities.

3. Method

3.1. Study area

Our work is focused on urban neighborhoods in Northern Utah, a semi-arid region where settlement patterns were shaped by the availability of water and in which water-based features are a prominent feature of the local landscape. Utah lags in research on urban access to green space (Rigolon, 2016). Indeed, urban and regional planning in the state is enjoying a new popularity as cities face unprecedented growth (Scheer, 2012; Envision Utah, 2013). With a population of three million, its growth rate is more than double the national average (1.75% from 2014 to 2015 compared to 0.79% nationwide) (US Census Bureau 2015). Population growth and affordable home and rent prices contribute to housing demand, particularly for multi-family units. The semi-arid climate and mountainous landscape of Utah historically drove a human settlement pattern in which the population is primarily contained to a corridor along the west slope of the Wasatch mountain range where water in rivers and streams from mountain snowmelt allowed early European settlements to thrive.

3.2. Data sources

Household sampling for the current study was structured by previous work in a larger study of urban water systems. That project has produced a water-oriented typology of ~1300 urban neighborhoods (as defined by census block group boundaries) capturing the diverse combinations of social, built, and natural structural contexts that characterize Northern Utah's urban residential areas (Jackson-Smith, Dolan et al., 2016). The resulting typology of urban neighborhoods was used to guide sampling design for a major survey of household residents' values, attitudes, and behaviors described in further detail in the next section; the survey sampled households from 23 representative neighborhoods that were varied along a range of distance from urban waterways.

Waterways in or near our study neighborhoods were identified using the Flowline feature set of the National Hydrography Dataset (NHD) generated by the US Geological Survey. This dataset includes nearly all major and minor waterways within the urban environment, and delineates naturally occurring streams and creeks, but also built water features, including canals and ditches. We used two classifications provided by this service: StreamRiver (hereafter, river): "a body of flowing water" and CanalDitch (hereafter, canal): "an artificial open waterway constructed to transport water, to irrigate or drain land, to connect two or more bodies of water, or to serve as a waterway for watercraft" (USGS, 2015). Waterways were selected for this study (and considered 'local') regardless of size, width, or type of waterway if they bisected the neighborhoods in question or flowed near the boundary lines. Since there were no neighborhoods with more than one waterway, neighborhoods were classified as either a 'river' neighborhood or a 'canal' neighborhood.

3.3. Household survey

Measures of household attributes and the perceptions and interactions of adult residents with local urban waterways in the study neighborhoods were captured using data from a large household survey conducted in the summer of 2014 (Jackson-Smith, Stoker et al., 2016). Over 4000 housing units were randomly sampled from county and city property tax rolls (approximately 180 households in each of the 23 neighborhoods). The survey was implemented using a "Drop-off/Pick-up" method, where field staff made repeated door-to-door visits until they met and were able to personally ask an adult at each sampled residence to fill out the questionnaire, then made arrangements to stop by to later pick up. Three of the neighborhoods included supplemental samples to increase the numbers of respondents living adjacent to urban waterways. In total, 2343 households returned completed surveys for a response rate of 62%.

Household characteristics were captured using binned ordinal indicators for respondent education (less than high school, high school diploma, some college, vocational or technical degree, 4-year college degree, or graduate degree), household income before taxes in 2014 (under $25,000, $25,000-$49,999, $50,000-$74,999, $75,000-$99,999, and over $100,000), and tenure status (rent or own). Respondents were also asked to mark the category or categories that 'best described their race or ethnicity' and were given five options plus an "Other" write-in option. Due to the high concentration of non-Hispanic whites in Utah, responses were collapsed for this analysis into three categories: white only, Hispanic/Latino (alone or in combination with any other category), and all other ethnicities or races. Respondents were also asked how long they lived at their current residence using five answer options: less than 1 year, 1–3 years, 3–5 years, 6–10 years, and more than 10 years. We use a collapsed binary version (less than/more than 5 years) in the analysis below. Finally, they were asked if any household members under the age of 18 were living at the residence.

In addition to questions about respondent and household characteristics, the instrument for each different neighborhood included a map showing the location of a nearby urban waterway found within or bounding that neighborhood. This page included the question: "Have you ever spent time in or near this river/canal?" with three answer choices: no/yes/not sure (Fig. 1). Those answering 'not sure' to the first question were coded as not having been to the waterway. A second question asked: "Before filling out this survey, how familiar were you with the parts of this river/canal that flow through or near this neighborhood?" on a 5-point scale from 'Never knew it was there' (1) to 'Very familiar' (5) (Fig. 1). A third question (not shown in Fig. 1) asked "Overall, how do you think the (*local waterway name*) influences quality of life in this neighborhood?" and included five answer options ranging from 'negative influence' to 'positive influence.' Individual answers to this question were aggregated at the neighborhood-scale to generate the average 'impact on neighborhood quality of life' attributed by respondents to their local waterway. Finally, we asked respondents "Which of the following aspects of this river/canal have had a negative or positive impact on you or your household?" Four aspects were presented (place to visit and walk, place to play, sights and sounds, and habitat for wildlife) and answers were coded using a five-point scale ranging from 'strong negative impact' (1) to 'no impact' (3) to 'strong positive impact' (5). In nearly all cases, respondents reported either 'no impact' (3) or a positive impact (4 or 5). We used answers to this question block to develop indicators of different forms of interaction with local waterways.

3.4. Geospatial data

Proximity of a respondent household to its local waterway was operationalized in two ways: (*i*) whether or not their parcel was immediately adjacent to the reference waterway and (*ii*) the distance from the respondent's home to the nearest Access Points (APs) where they could see and/or spend time near the water. We counted as 'adjacent' parcels whose property lines directly abutted the relevant urban waterway, providing essentially private access to this public amenity. In total, 150 respondent households were identified as living adjacent to their reference waterway.

APs were identified by visually plotting potential points of pedestrian access using Google Earth and then ground-truthing these sites by visiting and photographing each one in the field (Fig. 2). We classified APs based on whether access was open to the public. We then

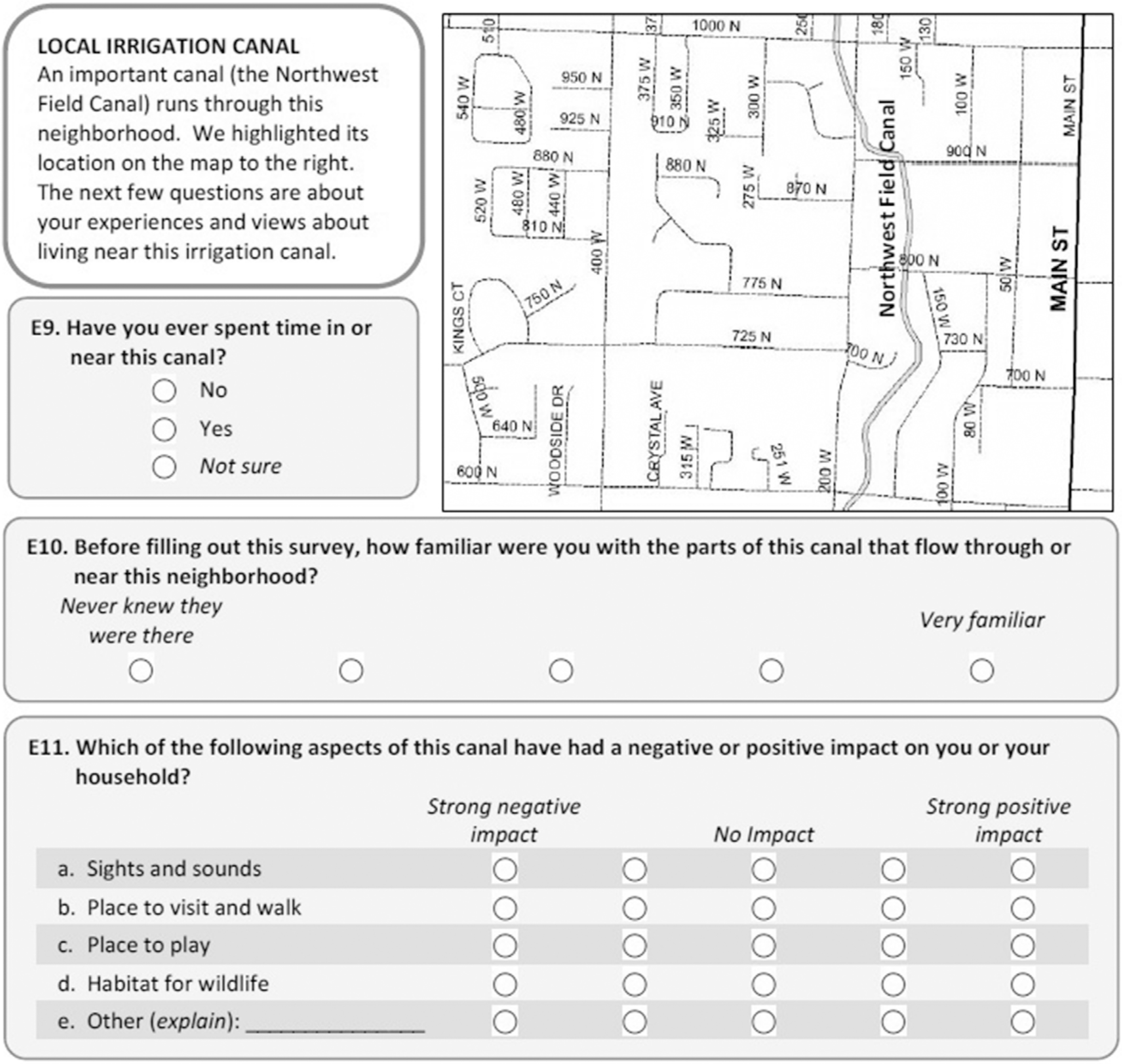

Fig. 1. Sample customized household survey questions.

calculated the distance in meters from each respondent's parcel to the nearest AP along the road network. For all surveyed neighborhoods, the distance was calculated using the OD Matrix tool in ArcGIS (v. 10.3.1), using parcel data from the Salt Lake County and Cache County Recorders Offices and street network data from the Automated Geographic Reference System (AGRC). Household locations were represented by parcel centroids. The OD Matrix tool snaps starting points (i.e. household locations) to the nearest point on the street network and then identifies the shortest network path from that point to an AP. Fig. 3 illustrates results for a typical suburban neighborhood in the Salt Lake Valley, with warm-to-cool colors indicating increasing distance from an AP, and the identity of the nearest AP to each parcel (left and right, respectively).

3.5. Analysis approach

We used both bivariate and multivariate statistics to assess the associations between household characteristics, proximity to blue spaces, waterway characteristics, and a respondent's reported familiarity and time spent at urban waterways. For the present analysis, we included

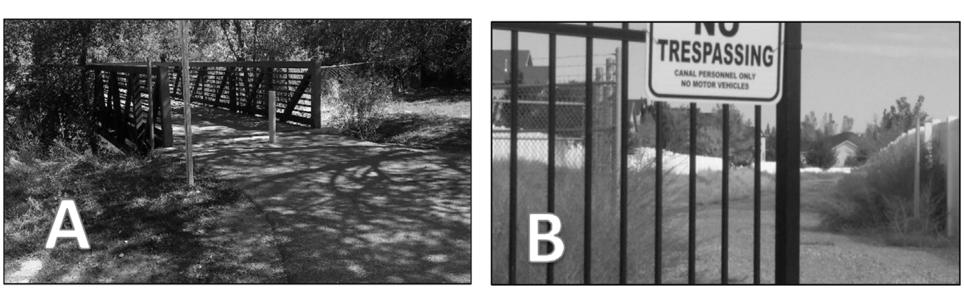

Fig. 2. Examples of public (A) and private (B) access points.
Source: Jordan Risley, 2015

Fig. 3. Maps of relative distance between residential parcels and the nearest access points (AP) (left map) and the boundaries of each residential area linked to a specific access point (right map).

only those households living in a subset of our study neighborhoods that were either bisected or bounded by a waterway. This resulted in a total of 1450 randomly sampled households from 13 neighborhoods: seven with rivers and six with major irrigation canals as their local waterway. Responses from these households are used for all descriptive and bivariate statistics reported below. For our multivariate models, we also included households from a supplemental (non-random) sample of respondents whose property directly abutted waterways (n = 70) to increase explanatory power about the associations between proximity and familiarity/use of waterways.

For bivariate comparisons of categorical variables, we used Pearson's chi-square tests to assess statistical significance. To evaluate differences in the mean values of continuous variables by subgroups, we used a *t*-test (for 2-group comparisons) and the standard Analysis of Variance (ANOVA) F-statistic with Tukey's post hoc comparison tests (for comparisons among more than 2 groups). Statistical significance is assumed reported at the 95 percent confidence level.

To identify factors that shape familiarity and use of local urban waterways, we estimated a series of multivariate models. Initially, we estimated an ordinal logistic regression model to see how measures of accessibility, blue space characteristics, and household features were related to how familiar respondents are with their local waterway. We then estimated a binomial logistic regression model using similar predictor variables to explain variation in the likelihood that respondents have been to their local waterway. Finally, we estimated a series of bivariate models to assess whether different factors were related to the likelihood that a respondent reported positive benefits from different forms of interaction with their local blue spaces. For each of these models, we avoided using combinations of variables that might present multicollinearity problems. The overall model goodness of fit was assessed using Pearson's chi-squared tests. We also used a stepwise nested modeling approach to highlight the relative contributions of each block of predictor variables toward explaining variation in the dependent variable, as evaluated by changes in the negative 2 log-likelihood, Akaike's Information Criterion (AIC), and Bayesian Information Criterion (BIC) (Burnham & Anderson, 2004). Because of missing data on some of the indicators, the final sample size used in the analyses was n = 1179.

4. Results

4.1. Descriptive profile of study neighborhoods

Table 1 presents descriptive information about the characteristics of respondents' households, their levels of familiarity and time spent at local waterways, and perceptions about the impacts of local waterways on quality of life. Results are shown for the overall sample and for each of the 13 study neighborhoods. Just under a quarter of the respondents have graduate degrees or household incomes exceeding $100,000; another sixth have relatively low levels of formal education and income levels approaching the poverty level. About a quarter of respondents are renters. By design, the study neighborhoods present a diversity of socioeconomic contexts that represent the full range of conditions found in Northern Utah.

The study neighborhoods also demonstrate significant variation in the degree to which local residents engage with their local waterway and their perceptions about whether the presence of urban waterways has a positive impact on their quality of life. Overall, about 71 percent of respondents had ever spent time at their local waterway. This varied from a low of 47 percent to a high of 95 percent across the study neighborhoods. The mean familiarity score (on a scale of 1–5) was 3.76 and ranged from 2.94 to 4.46 in our 13 study areas.

Table 1
Household characteristics by neighborhood.

	River neighborhoods (closest to farthest)							Canal neighborhoods (closest to farthest)						TOTAL
% per neighborhood	A n = 111	B n = 84	C n = 116	D n = 123	E n = 122	F n = 114	G n = 122	H n = 128	I n = 109	J n = 107	K n = 138	L n = 103	M n = 86	n = 1450
Resp. Education ***														
≤ High school diploma	34.9	13.3	1.7	12.3	6.7	18.8	5.9	26.2	18.9	18.4	3.7	36.4	11.8	15.7
Some college	34.0	37.3	14.8	32.0	31.7	42.0	21.8	41.8	34.9	45.6	27.6	44.4	41.2	34.0
4-year college degree	17.0	26.5	33.9	35.2	38.5	20.5	31.9	23.0	22.6	22.3	32.1	13.1	27.1	26.7
Graduate school	14.2	22.9	49.6	20.5	23.1	18.8	40.3	9.0	23.6	13.6	36.6	6.1	20.0	23.5
HH Income***														
Under $25,000	27.4	15.4	2.8	16.1	3.1	35.2	0.0	41.2	43.4	4.3	3.1	22.2	1.2	16.9
$25,000 – $49,999	34.7	21.8	4.6	25.9	22.9	31.5	14.2	37.8	25.5	13.8	21.5	36.7	7.4	23.2
$50,000 – $74,999	29.5	23.1	13.9	30.4	20.8	24.1	21.7	15.1	17.9	24.5	25.4	22.2	16.0	21.9
$75,000 – $99,999	7.4	20.5	23.1	12.5	18.8	6.5	23.6	4.2	4.7	23.4	25.4	12.2	19.8	15.4
Over $100,000	1.1	19.2	55.6	15.2	34.4	2.8	40.6	1.7	8.5	34.0	24.6	6.7	55.6	22.5
Homeowner Status***														
Renter	16.8	20.5	9.7	19.7	6.8	40.7	5.2	75.0	63.8	10.3	8.1	16.7	13.3	24.1
Race/ethnicity***														
White	61.3	89.0	95.5	94.3	93.3	87.5	93.4	71.9	78.3	92.2	92.5	66.3	86.7	85.0
Hispanic/Latino	23.6	1.2	0.0	3.3	1.9	3.6	0.8	16.5	14.2	2.0	2.2	19.4	2.4	7.0
All other	15.1	9.8	4.5	2.5	4.8	8.9	5.8	11.6	7.5	5.9	5.2	14.3	10.8	8.0
Children present (n.s.)	42.6	46.8	38.7	51.3	40.6	39.8	44.3	49.2	41.2	55.2	38.8	46.9	56.6	45.2
% Spent time***	81.2	73.1	94.7	68.6	81.9	84.1	76.6	48.0	66.7	63.3	71.9	66.7	46.5	71.3
Mean scores:														
Familiarity****	4.17	3.79	4.46	3.34	4.14	4.01	4.14	2.94	3.30	3.82	3.92	3.95	2.96	3.76
Overall QOL impact***	3.91	4.10	4.69	4.07	4.31	4.36	4.51	3.79	4.08	3.71	4.28	3.66	3.65	4.10
Visit & walk***	4.08	3.64	4.56	3.69	4.21	4.30	4.10	3.60	4.05	3.61	3.87	3.86	3.43	3.94
Play***	3.59	3.25	4.01	3.51	3.95	3.97	3.65	3.30	3.64	3.06	3.47	3.15	3.01	3.53
Sights & sounds***	3.65	3.62	4.27	3.68	3.67	3.94	3.87	3.41	3.67	3.23	3.58	3.24	3.09	3.63
Wildlife***	3.88	3.59	4.31	3.85	3.95	4.20	3.96	3.69	4.05	3.74	3.83	3.70	3.59	3.89
Distance to AP (m)***	367	392	413	491	514	708	1177	275	476	501	700	707	834	583

Note: Significance tests reflect meaningful differences between neighborhoods across the various categories. For categorical variables, these reflect chi-square tests. For mean values, the test is the *t*-test or ANOVA F-test. Statistical significance is denoted by asterisks: * = p ≤ 0.05; ** p ≤ 0.01; *** = p ≤ 0.001.

4.2. Are urban waterways viewed as positive amenities?

As noted in Table 1, most households viewed their waterways as having a positive influence on their neighborhood, with an average "Overall QOL impact" score of 4.10 out of 5. This ranged from a low of 3.65 to a high of 4.69 across the 13 study neighborhoods. Activities which produced the most positive impacts on respondents were visiting and walking near waterways (3.94) and appreciating the wildlife habitat provided by these blue spaces (3.89). The least impactful form of interaction was playing at or near the water. Generally, households living near *rivers* were more familiar, more likely to spend time, and more likely to say that the waterway positively influenced their or their neighborhood's quality of life (QOL) than those living in neighborhoods near *canals*.

4.3. Do passive or active interactions influence familiarity or time spent at blue spaces?

Results suggest that respondents who spent time and who were more familiar with the waterway were also more likely to report more positive impacts on their households from interacting with their local waterway through visiting and walking, playing, experiencing sights and sounds, and as habitat for wildlife (Table 2). They were also more likely to report overall positive impacts of the waterway on their neighborhoods quality of life.

4.4. Do high SES households live closer to waterways?

There appears to be a reverse socioeconomic gradient with respect to proximity to blue spaces in our Utah study neighborhoods. Wealthier households tend to live farther than low-income households (Table 3). Similarly, renters lived an average of 105 m closer to the study waterways than people who own their own home. Respondents who identified as Hispanic or Latino lived 120 m closer than whites on average. Interestingly, there was no systematic linear relationship between a respondent's level of formal education, presence of children, or length of residence, and their proximity to waterways. In the same vein, living immediately adjacent to a waterway was not systematically related to any of our sociodemographic measures. Homeowners and longer term residents were more likely to live near publicly accessible access points, but the type of AP was unrelated to the other sociodemographic factors. The most consistent patterns were seen relative to the type of waterway. Households who lived in neighborhoods near a river (compared to those living near an irrigation canal) were more likely to have high levels of formal education, higher household income, be white, be homeowners, and to have lived in the neighborhood for more than five years.

4.5. Are higher SES households more familiar with and spend time at waterways?

Although higher SES households in our study areas tend to live farther away, they are still more likely to have spent time at and be familiar with urban blue spaces than lower SES households (Table 3). People with college and graduate degrees, households making more than $50,000 a year, homeowners, and long-term residents are all much more likely to have spent time at their local waterway. Whites are much more likely to spend time at the waterways (73% vs. 59% for non-whites), and also express more familiarity with these urban features (particularly compared to Hispanic/Latino respondents). Households with children appear to be somewhat less likely to be familiar with their local waterway than those without young people at home.

Table 2
Associations between time spent and familiarity with positive interactions with waterway and perception of waterway influence on the quality of life for the neighborhood.

		Impacts from Interactions with Waterway								Perceived Impact on Neighborhood Quality of Life	
		Visit & Walk		Play		Sights & Sounds		Wildlife Habitat			
Mean scores											
Randomly selected respondents		3.94		3.53		3.63		3.89		4.10	
Did respondent spend time at waterway?			***		***		***		***		***
Did not spend time		3.34		3.14		3.14		3.42		3.65	
Spent time		4.18		3.68		3.82		4.07		4.29	
How familiar is respondent with waterway?			***		***		***		***		***
Never knew it was there	(1)	3.20	*a*	3.06	*a*	2.99	*a*	3.26	*a*	3.29	
	(2)	3.40	*a*	3.15	*a,b*	3.13	*a,b*	3.42	*a,b*	3.74	*a*
	(3)	3.71		3.36	*b,c*	3.37	*b*	3.67	*b*	3.96	*a*
	(4)	4.00		3.55	*c*	3.63		3.96		4.16	
Very familiar	(5)	4.28		3.77		3.98		4.18		4.38	

Notes: Statistical significance for mean score reflects significant *t*-test or ANOVA F-test statistic; letters reflect groups that are statistically indistinguishable using a Tukey HSD post-hoc test. Statistical significance is denoted by asterisks: * = p ≤ 0.05; ** p ≤0.01; *** = p ≤ 0.001.

Table 3
Socioeconomic and race/ethnicity status by blue space characteristics and positive interactions.

						Mean Score				
							Impact from Interaction			
	Mean Distance to any Access Point (m)	% Who Live Adjacent to Waterway	% Whose Nearest Access Point is Public	% Whose Nearest Waterway is a River	% Spent Time	Familiarity	Visit & Walk	Play	Sights & Sounds	Wildlife Habitat
Education	*n.s.*	*n.s.*	*n.s.*	***	***	***	***	***	***	***
≤ High school diploma	545.3	10.4	46.5	45.0	56.4	3.43	3.79	3.32	3.35	3.63
Some college/vocational	583.1	9.4	44.0	47.7	68.8	3.69	3.80	3.42	3.50	3.84
4-year college degree	584.8	6.9	44.3	59.2	76.1	3.85	4.02	3.61	3.76	3.98
Graduate school	609.6	9.7	48.3	63.1	80.6	4.00	4.14	3.69	3.85	4.00
Household Income	***	*n.s.*	*n.s.*	*	***	***	*n.s.*	*n.s.*	**	*
Under $25,000	505.3	8.0	37.5	44.6	56.7	3.16	3.86	3.48	3.50	3.82
$25,000–$49,999	521.0	8.5	48.1	50.5	67.1	3.71	3.84	3.44	3.53	3.76
$50,000–$74,999	559.4	9.7	44.8	56.6	77.1	3.95	4.03	3.55	3.69	3.95
$75,000–$99,999	651.6	6.4	43.4	54.9	77.3	4.00	3.98	3.60	3.79	3.97
Over $100,000	668.3	11.1	47.1	57.7	77.8	3.93	3.99	3.54	3.69	3.96
Tenure Status	***	*n.s.*	***	***	***	***	**	*	**	*
Renter	502.2	8.9	35.1	38.1	55.8	2.99	3.83	3.52	3.50	3.78
Homeowner	607.2	8.5	48.9	59.1	76.5	4.01	3.99	3.54	3.68	3.93
Race/Ethnicity	**	*n.s.*	*n.s.*	***	***	***	*	*n.s.*	***	***
White	589.6	9.1	45.1	56.0	73.7	3.86	3.96	3.54	3.67	3.92
Hispanic/Latino	474.4	8.2	47.9	37.8	58.9	3.20	3.71	3.31	3.21	3.51
All other	633.6	7.1	48.2	48.2	59.2	3.31	3.93	3.50	3.61	3.84
Presence of Children	*n.s.*	*n.s.*	*	*n.s.*	*n.s.*	***	*n.s.*	*n.s.*	*n.s.*	*n.s.*
No	574.7	8.6	47.9	55.8	72.3	3.88	3.94	3.51	3.63	3.91
Yes	594.9	8.5	41.4	51.9	71.1	3.63	3.96	3.57	3.64	3.88
Length of Residency	*n.s.*	*n.s.*	***	***	***	***	*n.s.*	*n.s.*	*n.s.*	*
5 years or less	562.4	7.5	39.3	48.0	60.8	3.23	3.91	3.55	3.58	3.83
More than 5 years	595.1	9.5	50.1	58.2	79.3	4.14	3.97	3.53	3.68	3.94

Note: Significance tests reflect meaningful differences across the various categories. For categorical variables, these reflect chi-square tests. For mean values, the test is the ANOVA F-test. Statistical significance is denoted by asterisks: * p ≤ 0.05; ** p ≤ 0.01; *** = p ≤ 0.001.

4.6. Multivariate models to predict familiarity and use

While bivariate analysis suggests some intriguing patterns, to explore which factors are most influential in shaping time spent, interactions, or familiarity, net the effects of other drivers, we estimated a series of nested logistic regression models using our individual-level data (Tables 4–6). Logistic regression is the most appropriate approach for modeling dependent variables that are categorical, and coefficient estimates reflect changes in the likelihood of different outcomes associated with each independent variable (Agresti, 2012). Since responses were captured using a 5 point scale, we use an ordered logistic regression model to explain the degree of familiarity with local blue spaces (Table 4). For models explaining the likelihood of having spent time (Table 5) and of experiencing positive interactions through various activities (Table 6) we chose to use a binomial regression model that predicts the likelihood of a 'yes' answer.

In Tables 4 and 5, we report the results for models that sequentially include blocks of variables to capture the additive contributions of measures of accessibility, blue space characteristics, and household characteristics. Overall, model fit statistics suggested that each of the

Table 4
Ordinal logit regression of familiarity with waterway by accessibility, blue space characteristics, and household features.

	Model 1		Model 2		Model 3	
	odds ratios					
Accessibility						
Distance to AP (10 m units)	0.994	***	0.993	***	0.991	***
Adjacent	4.208	***	3.384	***	3.597	***
Access point is public	2.192	***	1.524	***	1.568	***
Blue Space Characteristics						
Local waterway is a river			n.s.		n.s.	
Mean neighborhood QOL			3.104	***	2.687	***
Household features						
4 year degree or more					n.s.	
White					1.494	*
Homeowner					2.283	***
Income over $50,000					n.s.	
Children present					0.747	**
Long term resident (> 5 years)					2.146	***
Model Fit						
n	1179		1179		1179	
Prob > chi2	0.000		0.000		0.000	
Log Likelihood	−1589.3		−1560.3		−1483.5	
AIC	3192.6		3138.6		2997.0	
AICC	3192.7		3138.8		2997.4	
BIC	3235.2		3193.3		3088.1	

Table 5
Binomial logistic regression of spending time at waterway by accessibility, blue space characteristics, and household features.

	Model 1		Model 2		Model 3	
	odds ratios					
Accessibility						
Distance to AP (10 m units)	0.994	***	0.993	***	0.991	***
Adjacent	7.297	***	5.637	***	5.234	***
Access point is public	2.166	***	n.s.		1.444	*
Blue Space Characteristics						
Local waterway is a river			1.741	**	1.642	*
Mean neighborhood QOL			3.473	***	2.762	***
Household features						
4 year degree or more					1.360	*
White					n.s.	
Homeowner					n.s.	
Income over $50,000					1.517	*
Children present					n.s.	
Long term resident (> 5 years)					1.799	***
Model Fit						
n	1179		1179		1179	
Prob > chi2	0.000		0.000		0.000	
Log Likelihood	−627.3		−597.2		−572.6	
AIC	1262.6		1206.3		1169.1	
AICC	1262.7		1206.4		1169.4	
BIC	1282.9		1236.8		1230.0	

suites of nested models are significantly better than a null model (significant chi-square) and model fit systematically improves with each sequential addition of new blocks of variables (e.g., negative 2 log likelihood, AIC and BIC values all decline). In Table 6, we report results only for 'full' models that include the complete set of predictor variables. In all three tables −we report the estimated odds-ratios associated with each of the predictor variables included in the model. The size and significance of individual variable coefficients remain relatively stable across the nested models, suggesting that each of the different predictor variables is robust with or without the presence of the other variables in the model. In the discussion below, we focus on the predicted odds ratios associated with each independent variable in the final full models for each dependent variable.

Table 6
Binomial logistic regression of interaction at waterway by accessibility, blue space characteristics, and household features.

	Visit & Walk		Play		Sights & Sounds		Wildlife	
	odds ratios							
Accessibility								
Distance to AP (10 m units)	0.994	**	0.995	**	0.995	**	0.995	**
Adjacent	n.s.		1.607	*	2.413	***	n.s.	
Access point is public	1.977	***	1.556	**	n.s.		n.s.	
Blue Space Characteristics								
Local waterway is a river	n.s.		n.s.		1.640	**	n.s.	
Mean neighborhood QOL	4.358	***	4.214	***	4.471	***	2.354	***
Household features								
4 year degree or more	1.581	***	1.478	**	1.720	***	1.317	*
White	n.s.		n.s.		n.s.		1.541	**
Homeowner	n.s.		n.s.		n.s.		n.s.	
Income over $50,000	n.s.		n.s.		n.s.		n.s.	
Children present	n.s.		1.293	*	n.s.		n.s.	
Long term resident (> 5 years)	n.s.		n.s.		n.s.		n.s.	
Model Fit								
n	1179		1179		1179		1179	
Prob > chi2	0.000		0.000		0.000		0.000	

Note: Statistical significance is denoted by asterisks: * = p ≤ 0.05; ** p ≤ 0.01; *** = p ≤ 0.001.

4.6.1. Accessibility

As predicted, proximity is positively associated with familiarity and use of urban blue spaces. The odds of being familiar with or spending time at a local urban waterway, net of the influence of other variables in the model, dropped with every additional 10 m of distance from an access point. Moreover, households living immediately adjacent to the waterway were over three times more likely to be familiar than those who do not live in parcels abutting the waterway (Table 4), five times more likely to spend time there (Table 5), and significantly more likely to have been positively impacted by playing at the waterway and experiencing the sights and sounds of the waterway (Table 6).

4.6.2. Blue space characteristics

The data suggest that characteristics of blue spaces influence household interactions with local urban waterways. Respondents whose closest access point was public were more likely to be familiar (Table 4) and spend time (Table 5) than those whose closest point was not publicly accessible. They were also more likely to visit and walk and play at these waterways (Table 6). Whether the local waterway was a river or a canal had little to do with the level of familiarity, but respondents near rivers were more likely to spend time than those living near a canal. Rivers are also more likely to be associated with positive interactions through sights and sounds (Table 5). Finally, water features that were viewed as positive amenities by residents (as reflected by higher scores on the mean neighborhood 'quality of life' impact score) were associated with higher levels of both familiarity and levels of interaction.

4.6.3. Household characteristics

The importance of household-level characteristics differed across the models. A respondent's level of formal education and income were not related to whether they were familiar with the local waterway (Table 4), but were positively related to the chances they had actually spent time at these urban amenities (Table 5). More educated respondents were notably more likely to report positive benefits from all forms of interaction while wealthier households reported more positive benefits from wildlife habitat provided by rivers and canals (Table 6). Meanwhile, length of residence was significantly and positively associated with familiarity, use, and positive interactions with urban waterways. Net the effect of length of residence (LOR), homeowners and white respondents were more likely to be more familiar, but not more likely to spend time or have positive interactions with blue spaces. One exception is the fact that whites were more likely than minority respondents to report that wildlife habitat provided by urban waterways had a positive impact on their household. Perhaps not surprisingly, households with children were more likely to play near the waterway, but having children did not affect familiarity or the likelihood of spending time or engaging in other forms of interaction with water features.

5. Discussion and conclusions

Our analysis confirms that urban blue spaces are perceived as positive amenities by urban households in Utah. Using a mixed methods approach that combines household survey data, field reconnaissance, and geospatial analysis, we found that the more local residents are familiar with and spend time at local waterways, the more likely they were to perceive that it positively influenced the quality of life of their neighborhood, and the more they were reporting positive experiences from different forms of interaction with these blue spaces. Like previous research that proposed links between green space and public health, we have reason to believe that blue space also contributes to well-being (Beyer et al., 2014; Ekkel & de Vries, 2017; Koohsari et al., 2015).

Our findings support the idea that structural aspects of local social, built, and natural environments can shape the relationship between people and their local water system (Hale et al., 2015). Specifically, the benefits from blue spaces in our study neighborhoods are experienced differently by residents based on their race and SES status. Higher SES and white households tended to live farther away from urban waterways than lower SES and Hispanic/Latino households. However, upper SES households were more familiar with and tended to spend more time at waterways. Access to (and benefits from) blue spaces is also mediated by land tenure and length of residence. Similar to the findings of (Cox et al., 2006) in their analysis of coastal waterways, we found that homeowners and long-term residents were much more likely to be familiar with and interact with these landscape features. Meanwhile, renters and more transient residents were less familiar with and less likely to use waterways − which may reflect a more restricted ability to find the time to spend near blue spaces.

It is clear that future research on blue spaces should take into account the nature of the waterway appears to make important differences. Wendel et al. (2011) found that lower-income census block groups in Florida were located closer to the lower quality stormwater ponds. In our study communities, we found that urban rivers were associated with more positive impacts on neighborhood and household quality of life and were associated with interactions with local residents than were irrigation canals in our study communities. Efforts to negotiate public access to irrigation canals, which are a ubiquitous urban water feature in this region but which are usually posted to prevent trespassing, could provide significant benefits to residents.

Our work was motivated by environmental justice goals that seek to expose spatial inequities in access to urban amenities (Gould & Lewis, 2012, 2016; Miyake, Maroko, Grady, Maantay, & Arno, 2010; Mukhopadhyay, 2017; Omer & Or, 2005; Sister et al., 2010; Smiley et al., 2016; Wolch et al., 2014). Because our data represents a snapshot, we could not find evidence of a process similar to "green" gentrification noted elsewhere (Gould & Lewis, 2012; Mukhopadhyay, 2017; Wolch et al., 2014), but the possibility of land market dynamics playing a role in future movement is possible due to renewed municipal interest in restoring waterways. The pattern of Utah households occupying what scholars might consider 'less desirable' space is consistent with recent work, for example, living close to a park has a small but *negative* effect on housing values in Salt Lake County (Li, Wei, Yu, & Tian, 2016). This may be an artifact of the stage of development that many Utah cities are currently experiencing since Utah's population is expected to double by 2060 (UDWR, 2012). It is possible that as space becomes more crowded amenities might have stronger associations with value. The spatial inequality found in this study could be planting the seeds of future green − or blue − gentrification if cities succeed in creating desirable public access to waterways as populations shift due to real estate market transactions. If prices increase around urban amenities, we would expect displacement of those who are currently living closer to the waterways. Similar patterns regarding green space have caused alarm in other cities around the world (Ngom, Gosselin, Blais, & Rochette, 2016).

That said, the social dimensions of access to blue spaces are clear. Social differences remain despite the fact that higher SES respondents tended to live farther from these waterways, a finding that challenges conclusions from urban green space studies in some other cities (Heynen et al., 2006). Previous research on decline, decay, and fear (Brownlow, 2006) suggest that water features are not always perceived as positive, especially in economically disadvantaged neighborhoods. This may reflect different cultural patterns of how waterways are used or perceived, but could also be an indication or real differences in quality of riparian areas or of the river or canal water itself in ways that we were unable to measure in our work. Future studies could incorporate more direct measures of environmental and health benefits or risks associated with each waterway (e.g., water quality, water-borne insect and disease prevalence, safety risks, participation in social or recreational activities near the waterway, risk of flooding, etc.) to test whether these factors could explain variation in the perception that blue spaces are a positive amenity.

One limitation of our work is a reliance on road networks for measuring distance to waterway access points in this study. It is possible that some households were assigned a longer travel path than they actually experience, particularly when residents are willing or able to travel by foot along on walking paths that could shorten their relative proximity to these amenities. However, our research finds that facilitating awareness and use of urban waterways might be more effective in increasing the benefits among lower SES households than merely reducing distances to these features. If the problem were only a matter of distance, then the obvious answer to promote blue spaces as a means to enhance health and quality of life for sustainable cities would be to increase proximity by either adding new blue spaces (e.g., daylighting buried waterways or adding artificial lakes and ponds) and/or adding more affordable housing options near existing waterways. Our results instead support ideas put forth by leisure studies that time for recreation is a privilege, and simply having close physical proximity to urban greenspaces may not suffice to enable greater awareness and use of these public amenities by lower SES or minority residents. To the degree that information and time are privileges that are available to certain social groups, it is important to consider these factors in guiding sustainable urban development. A better understanding of factors that influence familiarity and use of local waterways can assist efforts by conservation planners and environmental scientists to entrain the concern and will of residents on behalf of the ecosystem health of urban blue spaces. Finally, our results may or may not be generalizable to other regions. We encourage comparative research on blue spaces in other urban contexts to see if our findings are comparable to different social structure, built environments, and trajectories of urban growth.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.landurbplan.2017.06.008.

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Melissa Haeffner is a National Science Foundation Post-Doctoral Research Scientist in the People, Places, and Pipes social and engineering systems section of iUTAH (innovative Urban Transitions and Aridregion Hydro sustainability), a National Science Foundation funded EPSCoR project at Utah State University.

Douglas Jackson-Smith is a Professor in the School of Environment and Natural Resources at The Ohio State University.

Martin Buchert is a Senior Research Analyst with the Global Change and Sustainability Center of the University of Utah, where he is also an Assistant Adjunct Professor in the Department of City and Metropolitan Planning.

Jordan Risley is an undergraduate student at Utah State University.