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To the rescue—Evaluating the social-ecological patterns for bird intakes

R. Andrade[1] · H. L. Bateman[2] · K. L. Larson[3] · C. Herzog[2] · J. A. Brown[4]

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Abstract
Animals from urban areas are regularly brought into wildlife rehabilitation centers, providing untapped potential data records to inform management of wildlife species. Although rescues may be considered a wildlife stewardship behavior, not all 'rescues' may be warranted. Some animals are more likely to be brought into a rescue center than others, suggesting that human drivers underlying wildlife rehabilitation efforts are important to understand for urban conservation efforts. Literature has primarily focused on understanding the ecological drivers and implications of wildlife rescues. Our study is the first to investigate both the social and ecological drivers of bird rescues using census, household survey, and intake data. In Phoenix metropolitan area, Arizona, USA in 2017–2018, we found doves and common species were sent to the center most often. Altricial species (helpless at hatching) and young birds were more likely to be brought to the center, perhaps due to perceptions of young animals as vulnerable. We found rescues came from neighborhoods with higher incomes and residents with pro-ecological worldviews, perhaps reflecting a perceived responsibility for wildlife. Conversely, few rescues came from neighborhoods with a high percentage of Hispanic/Latinx residents, who often feel more interdependent with nature. Neighborhoods with greater numbers of rescues were more likely to have residents participating in yard stewardship activities as compared to neighborhoods with fewer rescues. Our findings are relevant to understanding drivers of wildlife stewardship actions and for intake centers who wish to reduce the occurrence of people bringing in wildlife that do not need to be rescued.

Keywords Conservation psychology · Conservation practices · Ecological Worldview · Nature experiences · Urban ecology · Columbiformes – Doves · Wildlife rehabilitation

Introduction

Increasing human activity threatens avian biodiversity through the global decline of abundance and, in some cases, species extinctions (Rosenberg et al. 2019). In addition to habitat loss and fragmentation, characteristics of the built environment can further exacerbate bird mortality in urban areas (Hager et al. 2017). Up to 1 billion birds die annually in North America from colliding with buildings (Loss et al. 2014). The use of rescue centers is a conservation strategy enacted to reduce human-induced mortality for wildlife (Pyke and Szabo 2018a). Rescue and rehabilitation studies have largely focused on the ecology of wildlife rescues. For example, rescue data can identify spatially explicit factors linked to wildlife mortality and morbidity (Pyke and Szabo 2018b) or detect and track disease (Camacho et al. 2016). Other work shows that various wildlife taxa are rescued at disproportionate rates and for different reasons, which may further impact the conservation effects of rescue efforts (Scheelings 2015).

Urbanization increases human-wildlife interactions and these actions can have both positive and negative effects on wildlife (Soga and Gaston 2016). Additionally, people's perceptions and emotions influence their interactions with

Andrade and Bateman shared the 1st authorship.

✉ H. L. Bateman
Heather.L.Bateman@asu.edu; heather.bateman@gmail.com

[1] School of Geographical Sciences and Urban Planning, Arizona State University, 975 S Myrtle Ave, Tempe, AZ 85281, USA

[2] College of Integrative Science and Arts, Arizona State University, 6073 S. Backus Mall, Mesa, AZ 85212, USA

[3] School of Geographical Sciences and Urban Planning, School of Sustainability, Arizona State University, 800 Cady Mall, Tempe, AZ 85281, USA

[4] Julie Ann Wrigley Global Institute of Sustainability, Arizona State University, 800 Cady Mall, Tempe, AZ 85281, USA

wildlife and their subsequent actions that may influence urban conservation (Jacobs 2009). People's interactions with wildlife can be based on how specific animals are viewed. For example, birds are often viewed favorably when they have a pleasant song or are colorful (Cox and Gaston 2015; Andrade et al. Unpublished). Likewise, people who feel anger and disgust toward House Sparrows (*Passer domesticus*) favor lethal and non-lethal removal of the species from nest boxes as a wildlife management strategy (Larson et al. 2016). A review by Soulsbury and White (2015) recognizes the importance of understanding social drivers of human-wildlife interactions in urban areas, but does not include data about wildlife rescues. Few studies have investigated the factors that underlie why people rescue wildlife, which can connect to understanding broader participation in pro-environmental behaviors. Here, we conceive of rescues from a wildlife stewardship perspective to provide a novel look into which ecological and social factors influence bird rescues and how to leverage these insights to achieve conservation goals. Conservation efforts are shaped by the decisions and support of individuals, creating a need for social science research that focuses on the aspects of why people engage in specific conservation activities such as wildlife stewardship actions (Dayer et al. 2020).

Although rescues occur across many wildlife taxa, birds are the most commonly rescued group (Pyke and Szabo 2018a). Widespread and common birds that live in close association with humans, such as doves and pigeons (Columbiformes), are among the most rescued species, likely because they are readily encountered (Tribe and Brown 2000). People often react emotionally to animals (Jacobs 2009) or feel a moral responsibility for their animal welfare (Whittaker et al. 2006), and as a result people are also more likely to rescue an injured animal or one perceived as helpless. For birds, chicks of various species have different rates of development, ranging from precocial to altricial, which may influence rescue behavior. Precocial species have well-developed chicks with eyes open, feathers, and mobile at hatching; whereas, altricial species have helpless chicks with no feathers at hatching. Younger animals who are assumed to be abandoned are often perceived as being vulnerable and in need of help (Martínez et al. 2014). This perception could increase the likelihood of young and juvenile animals being taken to a wildlife rehabilitation center. As a result, many wildlife admitted to rescue centers may not have an injury or illness but are instead rescued because they are young (Wimberger and Downs 2010). For other taxa, such as snakes and lizards, being rescued occurs not because of injury but because residents want wildlife perceived as problematic removed (Shine and Koenig 2001). In the light of studies observing drivers of wildlife rescues, some species might be rescued because of their local abundance or due to a person's perception that the animal is injured. Alternatively, wildlife may also be removed if they are perceived as a nuisance (Pitts et al. 2017).

A 'rescuer' is someone who intervenes when they believe wildlife need assistance and takes an animal to a rehabilitation center. Therefore, rescues can be considered a wildlife stewardship behavior intended help an individual animal or to support broader conservation goals (Larson et al. 2016). Yet, despite stewardship intention, the actual conservation value of a rescue depends on a number of factors, such as the functional traits of the species or risk of mortality versus rescuer-perceived injury. Considering who participates in wildlife rescues gives insight into the underlying mechanisms of wildlife stewardship and their conservation implications. Wildlife stewardship is influenced by a person's intrinsic motivations and person's capacity to participate in a given activity (Bennett et al. 2018). Intrinsic motivations include attitudinal factors, such as appreciation of wildlife, which influence local bird conservation efforts (Goddard et al. 2013; Belaire et al. 2016). Moreover, fear of animals as being dangerous or harmful may lead people to avoid them (Soga et al. 2020), decreasing the potential for rescue. Pro-ecological worldviews, or value orientations (Dunlap et al. 2000), have also been linked to yard stewardship activities (Robbins et al. 2001). However, these intrinsic motivations are often constrained by external factors that influence a person's ability to engage in stewardship activity. For example, older people and those with higher socioeconomic status have a greater capacity to engage in stewardship activities due to increased free time and monetary resources (Clucas et al. 2015). Additionally, people who identify as Hispanic/Latinx are often less likely to participate in stewardship (e.g., Merenlender et al. 2016), perhaps due to barriers to participation or distinct ecological worldviews as being interdependent instead of in control of nature (Johnson et al. 2004).

We pose the following question to better understand drivers of wildlife stewardship through the lens of bird rescuers: what social and ecological factors motivate and constrain bird rescues, and can bird rescues signal opportunities for other pro-environmental behaviors? We explore these questions by examining people's motivations and capacity for rescuing birds, and the traits of birds being rescued using social-ecological data collected from a wildlife rescue center in a metropolitan area of the desert southwestern U.S. We tested five hypotheses linked to two sets of testable predictions (Fig. 1). First, regarding bird traits, we expect that: (1) common and conspicuous bird species will be rescued more frequently due to a higher likelihood of encounters, and (2) bird traits related to the perception of vulnerability will cause people to rescue younger birds and birds with altricial development at higher rates compared to adults or precocial species. Second, for people engaging in bird rescues, we tested the predictions that rescuers were from

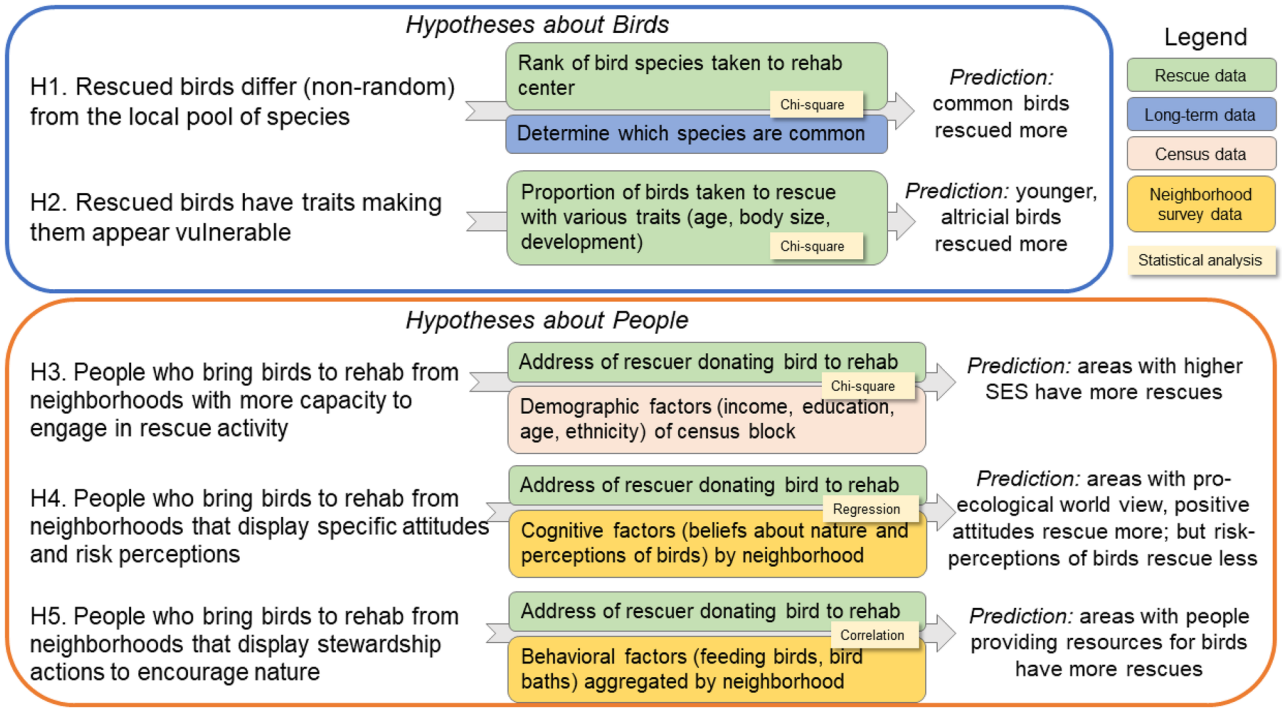

Fig. 1 Study design of hypotheses and predictions on what types of birds get rescued most (hypotheses about nature) and who brings birds to wildlife rehabilitation centers (hypotheses about people) from Maricopa County, Arizona, United States

neighborhoods with: (3) higher socioeconomic capacity, as measured by income and education, (4) greater intrinsic motivation to engage in stewardship activities based on pro-ecological value orientations and positive views about birds. Lastly, regarding bird rescues as a stewardship behavior, we expected that (5) the number of birds rescued in a neighborhood will be positively related to householder engagement in other stewardship actions in residential yards and gardens (e.g., planting native vegetation, bird feeding, installing nest boxes).

Methods

Study area

Our study takes place in the Phoenix Metropolitan area of Maricopa County Arizona, which is situated in the Sonoran Desert of the United States (Fig. 2). The region has an estimated 4.5 million population and has been growing rapidly (U.S. Census Bureau 2019). Research on the avifauna of Phoenix documented that the spatial and environmental configuration of urban development has influenced bird biodiversity throughout the city (Allen et al. 2019). Specifically, the local bird community can vary from urban-dwelling, non-native species such as House Sparrow (*Passer domesticus*) and Rock Pigeon (*Columba livia*) to native desert specialist species such as Gambel's Quail (*Callipepla gambelii*) and Cactus Wren (*Campylorhynchus brunneicapillus*), depending on the location within the city. As a result, people living in Phoenix experience different local bird communities, largely influenced by sociodemographics and related to the urban environment, such as grassy mesic yards versus low water-use xeric landscaping (Warren et al. 2019).

Rescue data

We analyzed bird intake data from a wildlife rehabilitation center in the Phoenix Metropolitan Area, Liberty Wildlife, collected during 2018 (Online Resource 1). The dataset included 9,397 records of birds and other wildlife brought to the facility by the public or from volunteers responding to calls from the public. Facility volunteers record information on the person bringing in the bird, such as contact's address, and the bird brought in, such as bird species and approximate age. From the bird intake records, 1,807 were excluded due to incomplete location or rescue data. We used intake records to geocode the location of the address provided by the contact person (rescuer) to spatially match each person who rescued a bird to areas at two spatial scales: Census Block Groups (n = 6,422) and study neighborhoods, where household survey data were collected (n = 196; Fig. 2, Online Resourse 2. Our study focuses on location data of the rescu-

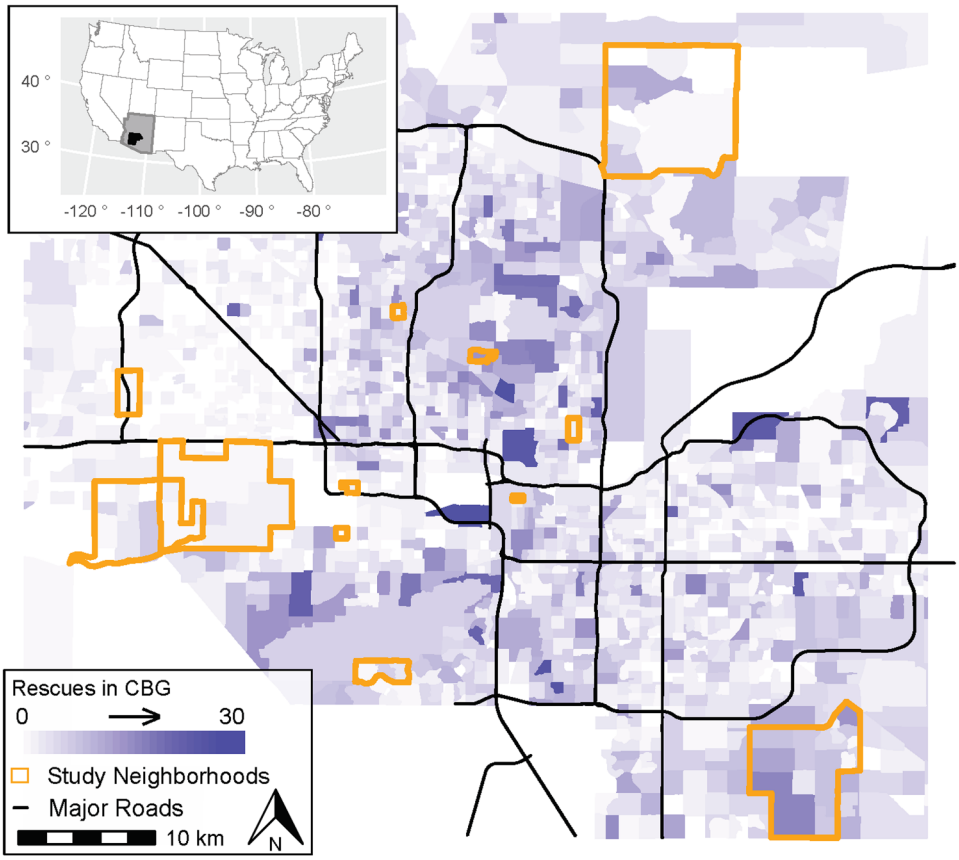

Fig. 2 Map showing frequency of bird rescues during 2018 occurring inside study neighborhoods (Larson et al. 2017) and inside Census Block Groups (CBG represented shaded polygons) from Phoenix Metropolitan Area, United States. Darker shading represents increasing number of birds rescued. The number of bird intakes range from 0–30 in census blocks and 0–102 in study neighborhoods

ers' address which may not reflect where the bird was found. Similarly, this study does not have information on individuals who may try to treat or rehabilitate a bird themselves at home.

Ecological variables

We used five ecological variables from the bird intake data to address our theoretical expectations about birds taken to the rehabilitation center. Ecological variables included: bird species, species commonality (common or not common), type of species development (altricial versus precocial), relative age of the bird (young or adult), and conspicuousness based on adult body mass of the species (Online Resource 3). To address our first ecological prediction about bird species commonality (Fig. 1), we assigned species into two groups: common and not common. This rank of commonality was determined by referring to long-term bird monitoring data collected in the Phoenix metropolitan area (Bateman et al. 2018). We denoted a species as common if the species had a proportional abundance greater than 5% of the total abundance of all species observed in Phoenix from the long-term dataset during 2017–2018 (Bateman et al. 2018). Common species from the long-term dataset were House Sparrow (*Passer domesticus*), Mourning Dove (*Zenaida macroura*), Rock Pigeon (*Columba livia*), Eurasian Collared-Dove (*Streptopelia decaocto*), European Starling (*Sturnus vulgaris*), House Finch (*Haemorhous mexicanus*), and Great-tailed Grackle (*Quiscalus mexicanus*), which represented over 63% of total observations.

To address our ecological prediction on perceived wildlife vulnerability (Fig. 1), we coded bird species based on species-specific development (based on Baicich and Harrison 1997). We coded bird species as altricial that are helpless at hatching, have eyes closed, lack feathers, and need to be incubated and fed by a parent bird. Bird species that are mobile and feathered at hatching were coded as precocial. We also categorized rescued birds into two groups, young or adult, based upon volunteer's classification of the bird's relative age at intake. Individual birds that volunteers recorded as infant, nestling, hatchling, or juvenile were classified as young; whereas, records stipulating adult were classified as adult. Finally, we categorized rescued birds based on average adult body mass of the species with the threshold being mass above 100 g deemed as large or conspicuous and species under 100 g as small.

Census data—social variables

We integrated bird intake data to demographics (social variables) using spatial coordinates of the home address for each

rescuer to identify the U.S. Census Block Group to which the rescuer belonged. Using Census data from the American Community Survey (ACS 2017), we evaluated four sociodemographic variables. The four social variables—income, education, age, and ethnicity—were approximated based on the U.S. Census Block Group (CBG) of the home address of the bird rescuer (ACS 2017, Online Resource 4). We coded these variables into ordinal categories to compare if certain groups of people were rescuing birds at higher or lower rates than expected given the sociodemographics of Maricopa county.

Data from the Census Block Groups were coded into six income groups based on median household income: <$25,000; $25,000-$49,999; $50,000-$74,999; $75,000-$99,999; $100,000-$124,999; and >$125,000. The number of residents with a Bachelor's degree or higher in a Census Block Group were categorized into four education groups: 0–24% of individuals, 25–50% of individuals, 50–74% of individuals, and 75–100% of individuals. Rescuer age was measured using the median age of individuals in the Census Block Group: <25 years, 25–34 years, 35–44 years, 45–54 years, 55–65 years, and >65 years. Finally, ethnicity in a Census Block Group was coded using the U.S. Census question measuring if the person identified as Hispanic/Latinx and did not select white for their race. Hispanic/Latinx ethnicity was coded into four groups: 0–24% of individuals, 25–50% of individuals, 50–74%, of individuals, and 75–100% of individuals.

Neighborhood data and ethical approval of study subjects

We related location information of bird rescuers to cognitive variables, representing intrinsic motivations, and other pro-environmental behavior using a long-term household survey conducted in the study area at the scale of residential neighborhoods. Data were derived from the Phoenix Area Social Survey (Larson et al. 2017, 2019), which is part of the Central Arizona-Phoenix Long-Term Ecological Research program. The survey involved a sampling design stratifying 12 neighborhoods across the Phoenix region (Fig. 2). Stratification was based on important indicators of social-ecological dynamics in the city, such as location (i.e., central, suburban, fringe), income, ethnicity, and housing age. Neighborhood boundaries were based on 2000 U.S. Census Block Groups because the survey was longitudinal and began in 2001.

Within the 12 study neighborhoods, surveys were mailed to 1,400 addresses. Participants gave written consent by returning surveys in mail. There was an overall response rate of 39.4% (n = 496). Household survey data were obtained under Arizona State University, Institutional Research Board approval (protocol #STUDY00004900). The survey included a wide variety of questions about human–environment interactions. We limited our analysis to variables most relevant to characterizing factors that may be related to our study, such as environmental value orientations and beliefs about birds. Verbatim questions we used to derive variables for our study are provided in Online Resources 5–7.

Cognitive variables derived from neighborhood data

We included three cognitive variables as factors we predicted would be associated with bird rescues that were measured in the household survey. Cognitive factors included ecological worldview, attitudes about birds, and risk perceptions. We measured ecological value orientations, known as worldviews, using the New Ecological Paradigm scale (Dunlap et al. 2000). The New Ecological Paradigm consists of 15 questions (verbatim in Online Resource 5) measuring biocentric versus human-centered worldviews on a 5-point scale. We averaged responses across the 15 questions, where higher numeric values indicated pro-ecological orientations. We measured people's attitudes by asking about their beliefs regarding birds in their neighborhood on a 5-point scale (verbatim in Online Resource 6). We measured perceptions of risk by asking respondents to what extent birds in their neighborhood were a problem. We coded responses from (1)-not at all a problem to (5)-a very big problem.

Stewardship variables derived from neighborhood data

We used the household survey to compare the number of bird rescues per neighborhood to other forms of wildlife stewardship in residential yards. Specifically, we included six stewardship behaviors that people might engage in to support urban birds and nature in backyards and gardens. Yard stewardship behaviors included: planting trees, planting desert vegetation, using vegetation to draw birds to property, maintaining bird houses on property, bird feeding, and providing water (verbatim in Online Resource 7). For each of the six items, we calculated the percent of respondents per neighborhood who indicated they engaged in the activity.

Statistical analysis

To test how social and ecological factors (H1, H2, H3 in Fig. 1) influence bird rescues, we matched the home addresses provided by rescuers to the corresponding Census Block Group for rescues that occurred in Maricopa County (n = 6,422). Cognitive factors and stewardship behaviors were excluded from county-level analysis because these data were only collected at the neighborhood-scale from the household survey. We used the Chi-Squared Test (χ^2) to determine how social and ecological factors were associated with bird rescues in Maricopa County to compare when patterns of rescues deviated

from expected events based on the social and ecological distribution of our sample (Agresti 2018). For ecological factors, we compared the number of rescues for each ecological category (e.g., the number of rescues that were common species versus non-common or altricial versus precocial species) to see if the percent of rescues from each category significantly differed (Online Resource 3). For social factors, we compared the percent of rescuers from each sociodemographic group to the expected demographic distribution of Maricopa County from Census data (Online Resource 4). We used a Bonferroni correction to adjust P-values of the Chi-Squared Tests to account for multiple comparisons (Benjamini and Yekutieli 2001). Although we did perform Chi-Squared analyses at both the metropolitan and neighborhood levels, we only present metropolitan results because the interpretations of analyses were identical, and the metropolitan-wide analysis provided a more robust and parsimonious view of social-ecological patterns.

To evaluate the relationship between cognitive factors (or intrinsic motivations) and bird rescues (H4 in Fig. 1), we used the 12 study neighborhoods where household survey data were collected. We also tested the relationship between bird rescues and other wildlife stewardship activities that support urban bird and nature conservation in the 12 study neighborhoods (H5 in Fig. 1). For our neighborhood analysis, we used home addresses provided by the rescuers and spatially matched these addresses to the corresponding study neighborhood. We only used data from rescuers who provided addresses that occurred within one of the 12 neighborhoods (n = 196 respondents across study neighborhoods). We aggregated survey data per neighborhood by averaging the individual responses from the household survey to compare to rescue data (n = 12 neighborhoods). We standardized the number of intakes per neighborhood by the population of people living within the neighborhood to account for higher rates of intakes coming from areas with more people.

We used a general linear regression, otherwise known as ordinary least squares (OLS), to determine how rescues were related to cognitive factors in the study neighborhoods (H4). For our model, we used the number of birds rescued per neighborhood as our dependent variable, with a Gaussian distribution. Independent variables of cognitive factors included ecological worldviews, attitudes toward birds in the neighborhood, and risk perceptions towards birds. We then used a Pearson Correlation to test the relationship between bird rescues per neighborhood and prevalence of other wildlife stewardship activities in the neighborhood (H5). For the correlation, we compared the percent of respondents per neighborhood who engaged in stewardship activities with the number of birds rescued in the neighborhood. All analyses were done in R version 3.5.1 (R Core Team 2018).

Results

Trends in bird rescues

A total of 6,422 birds were rescued in Maricopa County and taken to Liberty Wildlife Rescue Center in 2018. We reported the most rescued bird species in 2018 (Table 1) and a full list of rescued bird species (Online Resource 1). The top three common species rescuers took to the rescue center were doves, including Mourning Dove, Rock Pigeon, and White-winged Dove (*Z. asiatica*) (Table 1). Of these rescues, 196 occurred in the 12 neighborhoods in the household survey (Online Resource 2). Mourning Doves were the most rescued species in the study neighborhoods, followed by Gambel's Quail (Table 1). Species rescued frequently were often common species, with 58% of the total rescues being bird species abundant in the study region (Online Resource 3). Altricial species composed 82% of the total bird rescues in Maricopa, birds with a body mass > 100 g were 73%, and young birds were 56% of rescued individuals (Online Resource 3).

Ecological factors

Different bird species were rescued at varying rates in Maricopa ($\chi^2 = 43{,}451$, $P < 0.0001$). In general, a species' proportion of total rescues was positively related to their proportional abundance (Fig. 3). Species in the top 10% of the observed rank abundance frequency were rescued more frequently compared to the bottom 90% of species rank. In Maricopa, common species were rescued disproportionately more than expected, even given the more frequent occurrence of common species ($\chi^2 = 166.48$, $P < 0.0001$; Fig. 3). However, some rare species were rescued disproportionately in the Phoenix metropolitan area, such as American Kestrels (*Falco sparverius*), Rosy-faced Lovebirds (*Agapornis roseicollis*), and Cooper's Hawk (*Accipiter cooperii*). For example, only seven Cooper's Hawks were observed in bird surveys in the Phoenix metropolitan area from 2017–2018 (Bateman et al. 2018); however, over 70 were turned into the wildlife rescue center (Table 1).

Development type and age of the individual bird, which we theorized would be tied to people's perceptions of vulnerability, were also important ecological factors driving intake patterns (Fig. 3). Younger birds were rescued at a higher proportion than adults in Maricopa ($\chi^2 = 96.2$, $P < 0.0001$; Fig. 3). Similarly, altricial species

Table 1 The most common bird species brought to a wildlife rescue center in 2018 from Maricopa County, Arizona, United States. Species are listed from most to least common from rescues and indicated as (A) for altricial or (P) for precocial development. Intake data from 6,422 records from wildlife rehabilitation center found in Maricopa County. Long-term data on bird abundance (Bateman et al. 2018) collected from 12 study neighborhoods (Larson et al. 2017). Percentage in parentheses. Mass from Cornell Laboratory of Ornithology (The Birds of North America: https://birdsna.org)

Bird Species (Development type)	Body Mass (g)	Intake Data (%)		Long-term Data (%)
		County	Neighborhood	
Mourning Dove (A)	86–156	922 (14.4)	35 (17.9)	467 (9.2)
Rock Pigeon (A)	265–380	814 (12.7)	12 (6.1)	387 (7.6)
White-winged Dove (P)	125–187	688 (10.7)	13 (6.6)	96 (1.9)
Mallard (P)	1000–1300	589 (9.2)	6 (3.1)	14 (0.3)
Gambel's Quail (P)	160–200	421 (6.6)	23 (11.7)	167 (3.3)
House Sparrow (A)	27–30	409 (6.4)	14 (7.1)	490 (9.6)
Eurasian Collared-Dove (A)	140–180	365 (5.7)	9 (4.6)	248 (4.9)
Great-tailed Grackle (A)	105–190	267 (4.2)	15 (7.7)	246 (4.8)
House Finch (A)	16–27	207 (3.2)	11 (5.6)	373 (7.3)
Northern Mockingbird (A)	45–58	175 (2.7)	11 (5.6)	83 (1.6)
European Starling (A)	60–96	149 (2.3)	2 (1.0)	246 (4.8)
Anna's Hummingbird (A)	3–6	139 (2.2)	5 (2.6)	136 (2.7)
Inca Dove (A)	30–58	131 (2.0)	0 (0.0)	79 (1.5)
Gila Woodpecker (A)	51–79	115 (1.8)	5 (2.6)	94 (1.8)
Rosy-faced Lovebird (A)	46–63	112 (1.7)	1 (0.5)	12 (0.2)
American Kestrel (A)	80–165	102 (1.6)	2 (1.0)	7 (0.1)
Curve-billed Thrasher (A)	61–94	84 (1.3)	0 (0.0)	81 (1.6)
Cooper's Hawk (A)	220–410	71 (1.1)	1 (0.5)	7 (0.1)
Great horned Owl (A)	910–2500	66 (1.0)	0 (0.0)	1 (0.0)

were rescued more than precocial species ($\chi^2 = 2{,}668.9$, $P < 0.0001$; Fig. 3). Species body mass, which we predicted would make certain birds easier for people to see and thus more likely to rescue, was also related to the proportion of rescues. Of the 6,422 birds rescued in Maricopa, over 73% were species with an average mass > 100 g ($\chi^2 = 1{,}377.2$, $P < 0.0001$; Fig. 3).

Social factors

Rescues were more likely to occur in Census Block Groups in Maricopa County with higher levels of income and education (Fig. 4). People living in Census Block Groups with a median household income below $50,000 rescued birds less frequently; whereas, rescues occurred more frequently in areas with an income above $75,000 ($\chi^2 = 700.02$, $P < 0.0001$; Fig. 4). Rescues were less likely to occur in Census Blocks that had less than 25% of their residents with a Bachelor's degree or higher ($\chi^2 = 1562.1$, $P < 0.0001$; Fig. 4). Hispanic/Latinx Census Blocks were negatively associated with the proportion of rescues in Maricopa County ($\chi^2 = 568.38$, $P < 0.0001$). Most people who rescued birds were from Census Blocks with less than 25% of the total residents identifying as Hispanic/Latinx (Fig. 4). Age of residents in a neighborhood was related to rescue rates ($\chi^2 = 524.18$, $P < 0.0001$); although, this did not follow a clear gradient compared to the other variables (Fig. 4). Rescues were more likely to occur in areas with middle-aged residents, with the majority of residents between 35–54. However, a lower proportion of bird rescues were from areas with the oldest (> 65 years) and youngest age (< 24 years) groups compared to the total population (Fig. 4).

Cognitive factors

The overall model testing the influence of cognitive drivers on bird rescues in the study neighborhoods was significant ($R^2 = 0.61$, $F_{(3,8)} = 6.82$, $P < 0.014$). However, we found that

Table 2 Descriptive statistics for cognitive factors (beliefs and attitudes) used to relate to bird rescues in 12 study neighborhoods with a total of 496 respondents in 2017 from Phoenix, Arizona, United States. Responses for the three factors are on a scale of 1 to 5 with 5 being the most eco-centric, having the most positive attitude, or believing birds are a very big problem, respectively. Ecological Worldview based on the New Ecological Paradigm (NEP)

Variables from household survey	Mean ± Std. Dev	Median	Range (Min–Max)
Ecological Worldview (NEP)	3.70 ± 0.70	3.71	1.50–5.00
Attitudes about birds	3.30 ± 0.76	3.38	1.00–5.00
Risk perceptions about birds	1.47 ± 0.92	1.00	1.00–5.00

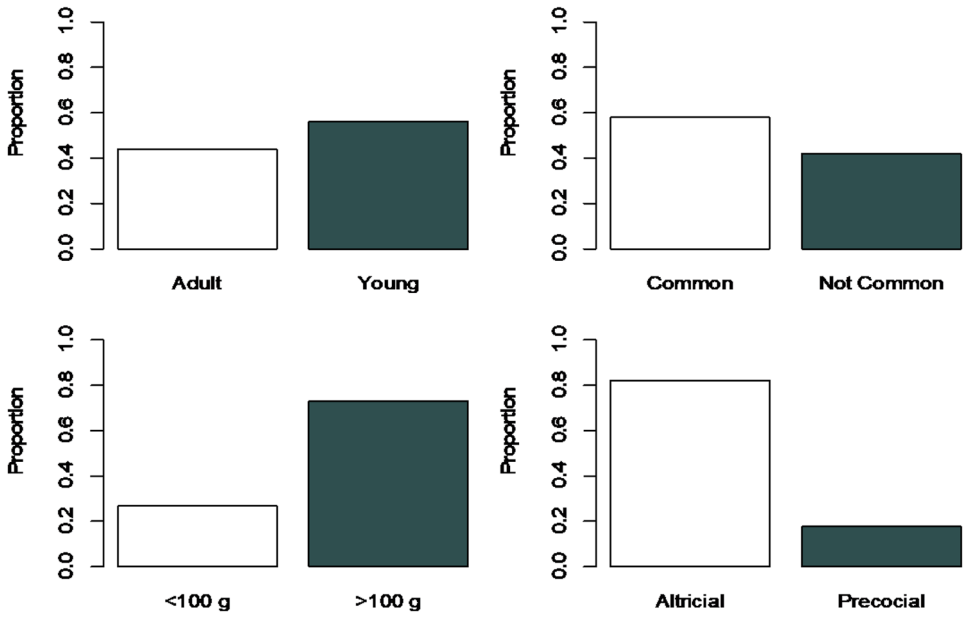

Fig. 3 Proportion of birds rescued during 2018 in Maricopa County, United States. We compared the proportion of birds rescued (open bars) from different ecological factors we predicted (solid bars) would be important determinants of people deciding to rescue a particular bird. Factors included: age of the bird rescued (young vs adult), commonality of species (common birds vs uncommon birds) as defined by long-term data collected on bird abundance (Bateman et al. 2018), body mass of species (smaller or larger than 100 g mass), and type of development (altricial birds are helpless and require parental care at hatching, precocial birds are feathered and mobile and more independent at hatching)

of the three cognitive factors (ecological worldview, attitudes, and risk perceptions; Table 2), only specific attitudes about birds were significantly related to the number of birds rescued per neighborhood ($\beta = 0.54$, $P = 0.016$; Table 3).

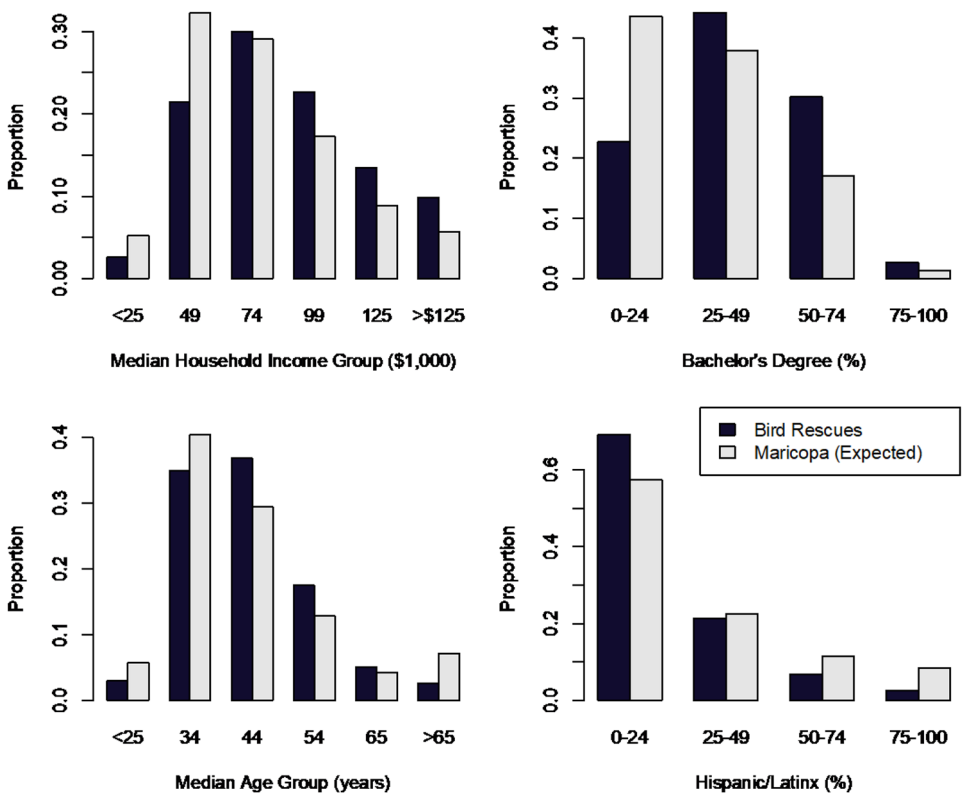

Fig. 4 Proportion of bird rescues occurring in 2018 across four sociodemographic groups in Census Block Groups (CBGs) from Maricopa County, Arizona, United States. The expected values were based on the sociodemographics of the county (grey bars) and observed values were the proportion where bird rescues occurred (black bars) inside CBGs. If the black bar is higher than the grey bar, then birds were rescued more frequently within that sociodemographic category than expected

Table 3 Explanatory drivers explaining the relationship between intrinsic motivations (cognitive factors) and number of bird rescues per neighborhood (dependent variable: number of rescues per 1,000 people) in 12 study neighborhoods for 2017–2018. Results from ordinary least squares regression. Ecological Worldview based on the New Ecological Paradigm (NEP). Bolded variable is significant

Explanatory Variables	Standardized β	β ± σ	t-value	*P*
Ecological Worldview (NEP)	0.38	2.18 ± 0.06	1.84	0.065
Attitudes about Birds	0.54	2.42 ± 0.05	2.39	0.016
Perceptions of Bird Risks	-0.11	-0.61 ± 0.03	-1.67	0.094

Specifically, we observed a strong positive relationship between attitudes about birds (Online Resource 6) and the number of rescues in the neighborhood ($r = 0.74$, Fig. 5). In contrast, neither pro-ecological worldviews nor perceptions of bird problems were significant explanatory variables in the model ($P > 0.05$, Table 3).

Other wildlife stewardship behaviors

We found that four of six wildlife stewardship activities had a positive relationship with the number of birds rescued per neighborhood (Table 4). Over 38% of respondents planted and maintained desert vegetation on their property (Table 4). A slightly smaller portion of residents, 30%, used vegetation specifically to draw birds to their property. Both the percent of residents per neighborhood using vegetation to draw birds to property ($r = 0.78$, $P = 0.003$) and those that planted desert vegetation ($r = 0.74$, $P = 0.005$) were associated with the number of bird rescues in the neighborhood. Bird rescues were also positively related to people providing resource subsidies, including bird feeding (29%, $r = 0.69$, $P = 0.012$) and providing water (24%, $r = 0.66$, $P = 0.020$). Planting trees was fairly common (37% of respondents) but not related to the number of bird rescues, nor was the least common activity of maintaining bird houses/nest boxes (14%, Table 4).

Discussion

Our study presents a novel perspective on bird rescues in a large USA metropolis as a form of wildlife stewardship in urban areas. Rescues are behaviors that have the intent of supporting nature and can influence ecological outcomes. However, wildlife rescues do not always lead to increased conservation. Intakes occur when a person perceives that an animal needs to be rescued and decides to take action. As a result, the animal or its condition may not always warrant rescue. However, intakes to wildlife rescue centers can also be a conservation measure that reduces wildlife mortality (Pyke and Szabo 2018a). The conservation value partly depends on the ecological traits or condition of the bird being recused, which determines if they are actually in need of help. Our findings show that young birds of altricial species are rescued at much higher than expected rates, indicating that birds are being rescued for a variety of reasons, which may not align with an injury. These results are supported by other studies on the drivers of wildlife stewardship actions, which show that people perceive younger animals as vulnerable (Mariacher et al. 2016). Additionally, we found that positive attitudes about birds could motivate bird rescue activities, although socioeconomic factors also facilitate or constrain the capacity to undertake such actions, as found elsewhere (Romolini et al. 2013).

The capacity to engage in stewardship

We found that residents in more affluent neighborhoods with higher levels of education rescue birds at higher rates (Fig. 4). This finding resonates with previous research showing that people of higher socioeconomic means have a greater capacity to participate in local stewardship activities (Chapin et al. 2010). Regarding age, research has documented older individuals are more likely to participate in environmental activities (Sorensen et al. 2018), with the expectation that older people have more time to engage in stewardship activities that support wildlife in residential yards and neighborhoods (Goddard et al. 2013).

Table 4 Relationship between bird rescues per neighborhood and the percent of survey respondents per neighborhood who engaged in other wildlife stewardship behaviors that support urban bird and nature conservation using a Pearson Correlation. Bolded variables are significant at $P < 0.05$

Wildlife Stewardship Actions	Respondents per Neighborhood (%)[a]	Correlation coefficient (r)	t-value	*P*
Planted Trees	37.17	0.30	0.99	0.343
Planted Desert Vegetation	38.55	0.74	3.53	0.005
Used vegetation to draw birds to property	29.89	0.78	3.89	0.003
Maintained bird houses on property	14.30	0.52	1.93	0.082
Fed the birds	29.19	0.69	3.05	0.012
Put out water for the birds	23.90	0.66	2.75	0.020

[a]Average number of respondents per neighborhood who engaged in stewardship activity

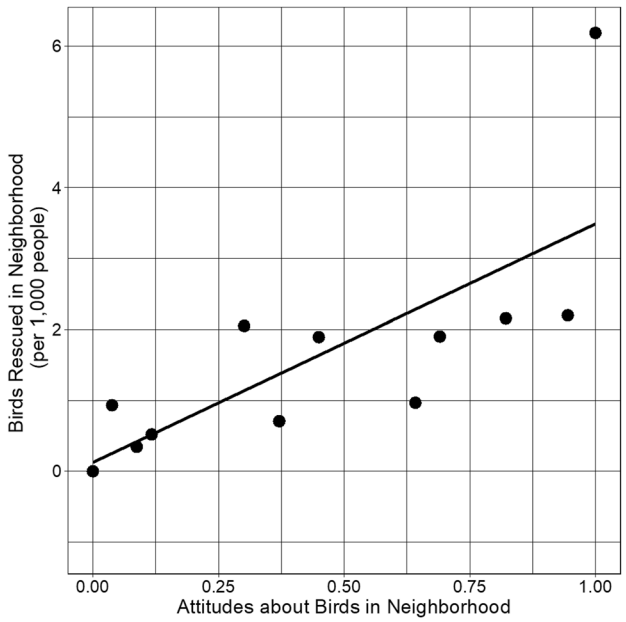

Fig. 5 Relationship between the average respondents' attitudes about birds and number of birds rescued per neighborhood (per 1,000 people) from Maricopa County, Arizona, United States. Linear relationship of $r=0.74$. Attitudes gathered from a household survey in 12 study neighborhoods (Larson et al. 2017) and standardized between 0 and 1 for visualization, where larger values represent more positive attitudes. Each point represents one neighborhood

However, our results show this does not hold true across all wildlife stewardship behaviors. Specifically, we found the relationship between householder age and frequency of bird rescues is non-linear, and that neighborhoods with primarily middle-aged residents had the highest numbers of rescued birds (Fig. 4). Therefore, middle-aged residents may be more inclined to partake in certain activities that do not take up a large amount of time or might be a one-time action.

Perceived environmental responsibility and concern

Engaging in stewardship activities to help the environment is often connected to feelings of responsibility and concern, and the associated behaviors are often related to certain cultural identity or related worldviews (Milfont et al. 2006; Olli et al. 2001). For example, people who identify as Hispanic/Latinx tend to view themselves as interdependent with nature, instead of in control of nature (Heyd 2004). In our study, we found neighborhoods with more residents who identified as Latinx were less likely to be home to bird rescuers (Fig. 4). As a result, people who identify as Latinx may be less likely to engage in activities they view as interfering with nature (Johnson et al. 2004). Additional research is needed to more fully understand how cultural beliefs and experiences influence stewardship and other human-wildlife interactions for the Latinx community.

A sense of responsibility can also be related to people participating in wildlife rescues because of concern for the welfare of the individual animal (Kidd et al. 1996; Pyke and Szabo 2018a). Concern for the individual bird's well-being is likely a key driver of younger birds being rescued more frequently than adults (Fig. 3). Specifically, nestlings and hatchlings were over 56% of the total intakes in 2018. Appearance-wise, many young altricial birds would not have fully developed feathers and appear defenseless compared to similarly aged precocial species (Sedinger 1986). Although the reason for intake was not reported, the prevalence of young birds of altricial species indicates that people likely perceive birds at younger life stages as needing to be rescued. This explanation is supported by other work showing people often feel a connection toward infant animals and perceive them to be in danger (Archer and Monton 2011; Levin et al. 2017).

Another motivation is the broader environmental concern for the species, especially for endangered or iconic species (Pyke and Szabo 2018a). Interestingly, some species are rescued at higher rates than expected based on their occurrence (Table 1). Certain birds, especially iconic species, may be rescued at higher rates due to people's perceptions that show a positive predisposition towards distinctive physical traits, such as size and color (Echeverri et al. 2019). However, other studies have shown that rescues are often opportunistic. People are more likely to rescue common or abundant birds simply because they are more likely to encounter these species, which means that rescue efforts may not equal the conservation status of a particular species (Wimberger and Downs 2010). Similarly, we found common, widespread species, such as doves and pigeons, made up the majority of rescues. The pigeon paradox, where people develop positive relationships with common species associated with human development, may highlight ways to further engage a broader group of people with nature in their spaces as they interact with these urban-dwelling species (Dunn et al. 2006).

Attitudes, values, and stewardship activities

Consistent with attitudinal theory, we expect specific attitudes about birds to be more influential on rescue activities than broader-based environmental values (Whittaker et al. 2006). This specificity principle has been found in other human-wildlife interactions, such as coyotes and bees (Sponarski et al. 2015; Larson et al. 2020). Our results confirm this relationship for bird rescue behaviors (Table 3). Neighborhoods with positive attitudes, specifically about birds, also had a greater number of bird rescues (Fig. 5). However, the perception that birds were problematic in a

neighborhood was not associated with the number of birds rescued in a neighborhood. General ecological worldviews were not strongly related to bird rescues either. Hence, evaluating specific attitudes and related psychological constructs (such as values and beliefs) in relation to wildlife is critical to understand wildlife rehabilitation efforts.

Given that human–environment interactions can be highly context-specific, and that relational values better capture those interactions and associated outcomes on human well-being (Klain et al. 2017; Knippenberg et al. 2018), we also recommend consideration of a variety of context-specific values and attitudes in future research, which would also require information about individual rescues (one of the major limitations of our study constrained to the neighborhood scale). Relational values reveal connections between humans and nature, and thus may be relevant for understanding how and why people engage in environmental behaviors such as rescuing wildlife (Chan et al. 2016; Klain et al. 2017). Moreover, since relational values encompass people's perceptions of which wildlife species belong in cities, these values may be important for understanding why people rescue different types of wildlife based on specific traits and threats, either perceived or real. In this study, bird rescues were not associated with perceptions of risk indicating people are not rescuing birds for the same reasons as snakes and lizards (Shine and Koenig 2001). For example, venomous Gila Monsters (*Heloderma suspectum*) and rattlesnakes (*Crotalus* species) are 'rescued' and relocated from neighborhoods in Phoenix as a risk mitigation strategy (Sullivan et al. 2004), instead of acts of stewardship. However, in Phoenix people who paid a service to remove snakes from their residence, did tend to view snakes as important to desert ecosystems and did not want them killed (Bateman et al. 2021). To further advance knowledge about which people rescue or remove particular wildlife under varying circumstances and why, a relational frame combining people's subjective views about appropriate interactions with wildlife with the real and perceived traits of non-human animals (e.g., relating to danger or disgust versus care or concern) is worthwhile.

Conservation implications

The long-term survival, and thus conservation value, of rescued wildlife is a subject of debate (Pyke and Szabo 2018a). However, some rescued individuals may not warrant rehabilitation and may fare as well or better on their own. Some species, including doves, have high predation rates on nests and thus have developed strategies for rapidly growing young that fledge (leave the nest) early and appear underdeveloped compared to adult birds (Westmoreland et al. 1986; Martin 1995; Miller 2010). Parents feed the young protein-rich crop milk (unique to this family), even after fledging (Blockstein 1989). Although young doves could appear helpless with poor flying ability, they could instead be in the care of parent birds and not need human intervention. Future studies should investigate the survival rate of rescued species and resources needed to care for species. Future directions could also investigate how non-essential "rescues" may influence the effectiveness of wildlife rescues as an overall conservation strategy (Mullineaux 2014).

The greatest conservation value of wildlife intakes is likely to come from rescue centers sparking educational opportunities (Tribe and Brown 2000) and positive human-wildlife interactions to combat extinction of nature experiences (Soga and Gaston 2016). For example, visiting rescue centers to view education animals can spur future conservation behavior, including donating money or volunteering (Feck and Hamann 2013). However, others found no relationship between people's engagement with wildlife centers and changes in behavior (Ballantyne and Packer 2011). Future research would benefit from studying how the point of contact between people and conservation professionals could encourage future wildlife stewardship and conservation efforts beyond the rescue event (Ballantyne et al. 2011).

Generating or changing behavior to be pro-environmental is not a simple undertaking, but the change is essential for urban conservation (Harrison and Burgess 2008). Providing education to people who are uninterested or lack the capacity to implement changes is often unsuccessful in promoting environmental behaviors (Kollmuss and Agyeman 2002). Instead, tailored messaging is more successful in promoting pro-environmental behavior (Pelletier and Sharp 2008). We propose that rescues could promote urban conservation beyond the rescue event by providing specific messaging and information to the communities that are already engaging in wildlife stewardship by intaking birds they perceive as injured. We found that neighborhoods with higher numbers of bird rescues already had a higher percentage of people investing in urban wildlife in their spaces through yard management (Table 4). Therefore, providing information about wildlife-friendly yards or native vegetation during intake to people interested in and with the capacity to engage in wildlife stewardship could support conservation efforts to create urban habitat in private residential yards (e.g., Narango et al. 2017).

Conclusion

Wildlife stewardship actions such as bird rescues are largely dependent on the person engaging in the behavior. Yet, a person's individual choices are varied depending on the rescuer, the species, and the traits of the animal being rescued. We show that bird species rescued in an urban environment of the U.S. tend to be common and have traits making them appear vulnerable. Such rescues appear in areas where people positively view and value local bird communities in their neighborhoods. Hence, these self-

perceived stewardship actions appear driven by species traits and perceptions of individuals who intend to care for birds perceived to need help. People who engage in bird rescue come from more affluent neighborhoods with a higher percentage of middle-aged residents and lower percentage of Hispanic/Latinx residents. These neighborhoods are home to residents who also participate in other wildlife stewardship activities, such as planting vegetation or providing water to support birds and promote nature in their private spaces.

Our study has implications for wildlife rehabilitation centers because some rescues are not always ecologically beneficial, such as when people rescue uninjured birds. Therefore, there lies an opportunity for centers to redirect people showing a desire to participate in wildlife stewardship to alternative activities. To reduce human interference of birds not needing rescue, we recommend centers have prominent messaging about when birds should be rescued and possible outcomes for those not needing rescue. Perhaps, through bird rescues, centers can promote bird conservation by encouraging efforts such as creating bird-friendly habitat in residential yards, engaging in community science, volunteering, or learning about wildlife natural history.

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Authors' contributions Riley Andrade: Methodology, Formal analysis, Resources, Visualization, Writing—original draft Heather L. Bateman: Conceptualization, Methodology, Supervision, Writing—review and editing, Project administration Kelli L. Larson: Methodology, Investigation, Resources, Supervision, Writing Cheyenne Herzog: Data curation, Methodology, Resources Jeffrey Brown: Writing – review and editing.

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Availability of data and material Data from Phoenix Area Social Survey available through the Central Arizona-Phoenix Long-Term Ecological Research Program (CAP LTER). https://sustainability-innovation.asu.edu/caplter/data/view/knb-lter-cap.667.1/

Code availability Contact the authors for code.

Declarations

Ethics approval Social survey data were obtained with Arizona State University, Institutional Research Board approval (protocol #STUDY00004900).

Consent to participate Social survey participants gave written consent through mailings.

Consent for publication Bird rescue data from 2018 were collected and provided by the non-profit organization, Liberty Wildlife (https://libertywildlife.org).

Conflicts of interest The authors have no conflicts to declare.

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