European Bison Conservation Newsletter Vol 17 (2025) pp: 15–34

Variation in the opinions of residents from urban, rural, and urban-rural municipalities regarding the population size of the European bison (*Bison bonasus*) in Poland

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Abstract: Understanding social tolerance is essential for effective wildlife management and conservation policy. Social tolerance enables alignment between biological carrying capacities and socially acceptable population sizes, enhancing both ecological outcomes and human-wildlife coexistence. This study investigates social tolerance of European bison (*Bison bonasus*) in different Polish regions by measuring opinion on population size. Survey data reveal that most respondents believe European bison populations in their local area, various voivodeships, and Poland are either the right size or too small. However, significant urban-rural differences were also measured. An ordinal logistic regression suggested that gmina type (rural, urban-rural, urban) significantly influences population size opinion. We found that urban respondents were more likely to believe populations are too low, while rural respondents were more likely to rate populations as too high. These differences were statistically significant at local ($\beta = -1.276$; p-value < 0.001) and national levels ($\beta = -1.7212$; p-value < 0.001), as well as for Podlaskie voivodeship ($\beta = -2.144$; p-value < 0.001). Additionally, Podlaskie emerged as the only voivodeship where local responses significantly differed from those of the general public (p-value = 0.004), suggesting a possible additional proximity-based effect on tolerance. These findings corroborate prior regional research, reinforcing findings of persistent urban-rural social tolerance divides. This research contributes new baseline insights into European bison social tolerance in Poland, and opens the door for further inquiry. Future studies should explore the mechanisms that influence tolerance patterns, including how specific experiences and explanatory variables influence more nuanced attitude and acceptability social tolerance metrics.

Keywords: European bison, human-wildlife coexistence, Poland, social tolerance, urban-rural divide, wildlife conservation

Introduction

Effective conservation is more than just a species' ability to be in a habitat, but also the ability of a habitat to be occupied by a species, both biophysically and in coexistence with other organisms (Decker & Purdy 1988). This fits into the larger goal of wildlife management: to enable the sustainable coexistence of humans and wildlife (Manfredo *et al.* 2009). To meet this coexistence goal, wildlife management balances limits of wildlife populations such as biological carrying capacity and human social tolerances (Giles, 1978; Carpenter *et al.* 2000; Bruskotter *et al.* 2015; Brenner & Metcalf, 2020; Nesbitt *et al.* 2023; Birdsong *et al.* 2024; Metcalf *et al.* 2024).

Understanding human social tolerance, the acceptance of wildlife and/or wildlife behaviors that one dislikes, is just as important to conservation outcomes as physical ecological limits such as biological carrying capacity (Decker & Purdy 1988; Brenner & Metcalf 2020). Even if a wildlife population limit can be biophysically sustained in an environment, if such numbers also result in higher conflict or resource competition interactions with humans, the negative experiences may drive humans to undermine overall conservation goals. Examples of counterproductive public intolerance that can be spurred by poor management include: voicing policy dissatisfaction, lobbying for decreased funding of the managing institutions, or subversive direct actions that undermine management objectives (e.g., wildlife poaching, inaccurate harvest reporting, or illegal wildlife harassment) (Bruskotter & Fulton 2012; Bruskotter *et al.* 2015). In short, wildlife management strategies that do not take into account both biophysical ecosystem limits and human tolerance for populations risk undermining desired management goals and sustainable coexistence outcomes. This is why wildlife managers must have strategies to increase tolerances of key groups if existing tolerances are not in alignment with management goals and the inherent intolerance is conflictual (Decker & Purdy 1988; Carpenter *et al.* 2000).

Human tolerances of wildlife are contextual, complex, and can vary depending on several factors, such as but not limited to: proximity to habitat/shared habitat, experience with damage or nuisance of a species, resource competition between the managed species and another species of human value, or opinion on the efficacy of the managing agency (Decker & Purdy 1988; Purdy & Decker 1989; Carpenter *et al.* 2000; Brenner & Metcalf 2020; Klich *et al.* 2018, 2021). Furthermore, human tolerances for species are not homogeneous. Due to the complex and contextual nature of wildlife tolerances, acceptability of species and their impacts can have distinct heterogeneity according to proximity and experience, often most pronounced in an urban-rural divide (Balčiauskas & Kazlauskas 2014; Doney *et al.* 2018; 2020; Klich *et al.* 2018; 2021; Oster-

mann-Miyashita *et al.* 2023). Questions remain as to not just what tolerances are amongst populations, but why they form in such a manner, how they are impacted by various experiences, and to what magnitude these individual experiences impact tolerance (Lischka *et al.* 2018; Brenner & Metcalf 2020; Pejchar *et al.* 2021; Nesbitt *et al.* 2023; Birdsong *et al.* 2024; Metcalf *et al.* 2024).

European bison research today is heavily focused on biology and population development, and research on social tolerance of European bison in Poland remains comparatively understudied (Klich *et al.* 2018; 2021; Schwerk *et al.* 2021). This gap in research on European bison, and the essentiality of understanding human tolerances in effective wildlife conservation management and outcomes, makes it a critical area of study. The increasing abundance of free-ranging European bison populations in Poland makes this issue particularly relevant, as it may foster the escalation of human–wisent conflicts (Klich *et al.* 2021; Perzanowski 2023).

This study builds upon foundational regional-level social tolerance studies of the European bison (Klich *et al.* 2018; 2021) to assess tolerance levels in previously unmeasured regions and within Poland. A wider measurement of social tolerance is a critical first step in understanding deeper tolerance nuances of the European bison in Poland.

Understanding the nuances of human tolerance has critical relevance to European bison managers and policymakers, especially when identifying how targeted education or targeted beneficial policy will increase individual wildlife tolerance where necessary, thus allowing for more closely aligned biological carrying capacity and social tolerance wildlife capacities. This multidimensional approach can help to understand where more work to increase social tolerance may need to be done in an effort to more efficiently and effectively fulfill management goals.

Materials and Methods

This study employed a multistage convenience sampling method to disseminate surveys to assess peoples' opinions of European bison populations within Poland. Surveys were sent to targeted Polish administrative districts (Polish: gminy) similar to municipalities. To identify solicited gminy, first the gminy were clustered into four voivodeship regions: A – Zachodniopomorskie, B – Warmińsko-Mazurskie and Podlaskie, C – Lubelskie, and D – Podkarpackie. These regions constitute distinct regions of free-ranging European bison herds. This was important to take into consideration for sampling given differing European bison herd densities, with one primary herd in each regions A, C, and D, and five in region B.

Gminy were then geographically stratified within each region (Fig. 1). We stratified gmina strata using geographic information systems software and overlaid shapefiles of Polish gminy. Strata were then assigned according to distance from a "core" of gminy. A gmina qualified as "core" if it has free-ranging European bison herds' primary designated habitat area (such as a State Forest or National Park) within its boundaries. An "adjacent" gmina is one whose shape file center is 10 km or less from a "core" gmina's borders. A "near" gmina is one whose shape file center is 11–50 km from a "core" gmina's borders. A "peripheral" gmina is one whose shape file center is 51–100 km from a "core" gmina's borders. Outside of these radii, a selection of gminy were selected as a "distant" stratum control group representing the general non-proximal Polish population.

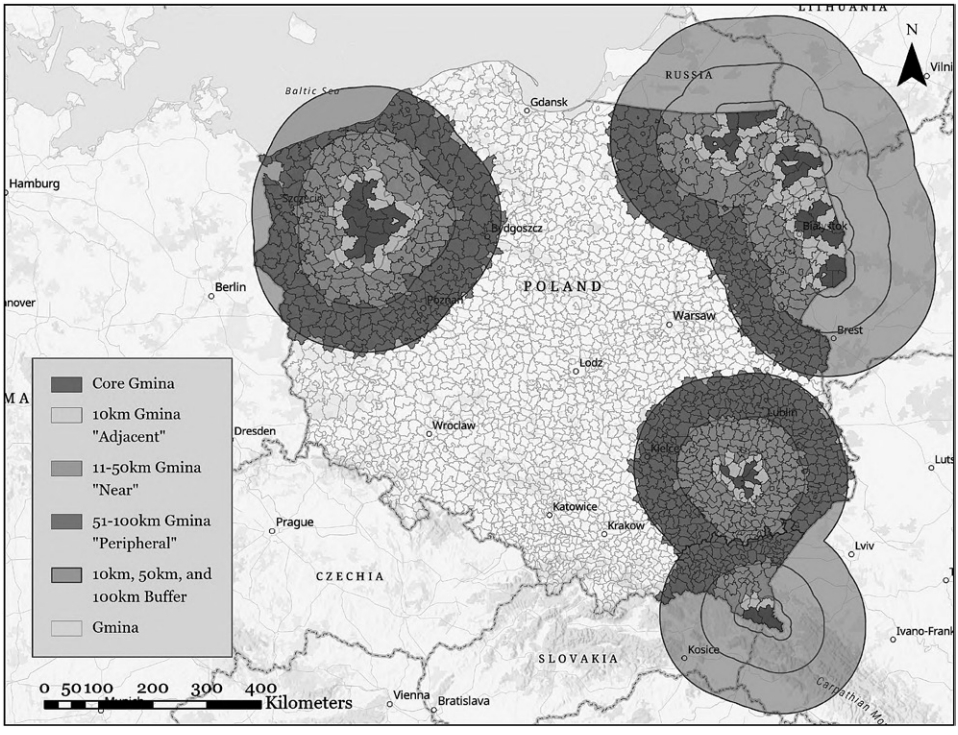


Figure 1. Gminy with Core, Adjacent, Near, and Peripheral strata indicated, and corresponding distance buffers

Once gminy were stratified by distance from "core" areas, within each distance stratum a proportionate substratified sample of gminy were selected for solicitation based on rural (wiejska), urban-rural (miejsko-wiejska), and urban (miejska) attributes. These attributes are determined by the Polish federal

government. The sample solicitation per gmina attribute (rural, urban-rural, urban) substratum was determined with the formula: Sample = (#AttributeGmina)*(AttributeGmina%).

For example, in a region cluster's stratum with 100 gminy, 80 of which are rural, 10 are urban-rural, and 10 urban, the survey was sent to 64 (80*0.8) rural gminy, 1 (10*0.1) urban-rural gmina, and 1 (10*0.1) urban gmina. This number was then adjusted in the following cases: (1) gmina attribute was present in stratum but not counted in proportion, in this case, 1 was solicited; (2) low overall sample size for stratum (<12), in this case, all were solicited. Control group samples in the distant stratum were at the percentage of gminy out of 100. For more details see Table 1. Once substratified, the surveys were emailed to randomly selected gminy via publicly available gmina administrative email addresses. Gminy were randomly selected using a Fisher-Yates shuffle algorithm on the substratified lists. Gminy were asked to disseminate the survey tool to their constituents via email with a link and post a flyer in their administrative office with both a link and QR code. Responses at this stage were at the constituents' convenience.

Non-response, as reflected by a lack of survey response from a solicited gmina after three weeks, initiated a follow-up solicitation. After three more weeks of non-response, replacement solicitation of another randomly selected gmina with the same sampling attributes occurred if possible.

While there was a risk of non-response bias, because European bison is a national animal of Poland, the risk of non-response was assumed to be less than that of other large herbivores.

Table 1. Gmina Attribute Substratum Proportionate Sampling Metrics example for one wave of solicitation

	Core	Adjacent	Near	Peripheral
A – Zachodniopomorskie				
Total	**10**	**18**	**99**	**172**
Rural	1	7	45	82
Urban-Rural	9	10	44	75
Urban	0	1	10	15
Rural %	10.00%	38.89%	45.45%	47.67%
Urban-Rural %	90.00%	55.56%	44.44%	43.60%
Urban %	0.00%	5.56%	10.10%	8.72%
Rural Sample	1* (0.1)	3	20	39
Urban-Rural Sample	9* (8.1)	6	20	33
Urban Sample	0	1* (0.055)	1	1

	Core	Adjacent	Near	Peripheral
B – Warmińsko-Mazurskie and Podlaskie				
Total	**19**	**41**	**78**	**122**
Rural	13	27	49	85
Urban-Rural	6	9	20	21
Urban	0	5	9	16
Rural %	68.42%	65.85%	62.82%	69.67%
Urban-Rural %	31.58%	21.95%	25.64%	17.21%
Urban %	0.00%	12.20%	11.54%	13.11%
Rural Sample	9	18	31	59
Urban-Rural Sample	2	2	5	4
Urban Sample	0	1	1	2
C – Lubelskie				
Total	**5**	**18**	**129**	**210**
Rural	2	12	85	140
Urban-Rural	3	4	34	52
Urban	0	2	10	18
Rural %	40.00%	66.67%	65.89%	66.67%
Urban-Rural %	60.00%	22.22%	26.36%	24.76%
Urban %	0.00%	11.11%	7.75%	8.57%
Rural Sample	2* (0.8)	8	56	93
Urban-Rural Sample	3* (1.8)	1	9	13
Urban Sample	0	1* (0.22)	1	2
D – Podkarpackie				
Total	**2**	**3**	**17**	**74**
Rural	2	3	12	50
Urban-Rural	0	0	4	17
Urban	0	0	1	7
Rural %	100.00%	100.00%	70.59%	67.57%
Urban-Rural %	0.00%	0.00%	23.53%	22.97%
Urban %	0.00%	0.00%	5.88%	9.46%
Rural Sample	2	3	8	34
Urban-Rural Sample	0	0	1	4
Urban Sample	0	0	0	1

E – Control					
Total	**1460**				
Rural	883	**Rural %**	60.48%	**Rural Sample**	60
Urban-Rural	369	**Urban-Rural %**	25.27%	**Urban-Rural Sample**	25
Urban	208	**Urban %**	14.25%	**Urban Sample**	14

***** Delineates manual override of statistic, with original statistic in (). Override of statistics occurs in following cases: (1) gmina characteristic present in stratum but not counted in proportion, 1 is added; (2) low overall sample size for stratum (<12), all are sampled. Control group samples are at the percentage of gminy out of 100.

The survey utilized a modified tailored design (Dillman *et al.* 2014). The survey was online and used the Qualtrics platform. The survey was in Polish and consisted of seven sections, taking respondents approximately 20 minutes to complete. Survey responses were anonymous. If participants provide personal or identifying information in open response sections, those data were separated, stored separately, and deidentified so as to maintain the anonymity of the response. No personal or identifying information was actively sought.

The survey used a mixture of Likert scales, binary responses, and categorical qualitative responses. In addition, there were three open-response questions. Aside from confirming that the respondent was at least 18 years of age and providing their home gmina, no other questions were required. This paper reports on a subsection of questions within the survey on opinions about the number of European bison in different voivodeships, the respondent's local area, and within Poland as a whole.

The survey was approved by Utah State University Institutional Review Board Protocol #13990 and Warsaw University of Life Sciences Rector's Committee for Ethics of Scientific Research Involving Humans, dated 5 July, 2024.

Results

Sampling results

As of 8 May, 2025, the survey resulted in 384 responses, of which 242 (63%) were valid (above the 40% threshold). 194 were 100% completed, 20 were 92% completed, and 28 were between 40%-89% completed.

Gminy were sampled in three waves, representing a solicitation of 23.97% of all gminy, and a response of at least one individual from 5.32% of all gminy (Tabl. 2).

Table 2. Sampling results by solicitation wave

Wave	Total gminy solicited	Gminy with responses	Gmina response rate	Total responses	Max in gmina
One	158	37	23.42%	89	27
Two	506	42	8.30%	60	8
Three	434	53	12.21%	93	10
Summative	594	132	22.22%	242	27

Basic demographic results

Respondent sex was skewed towards being more female-heavy than the Polish national proportion (Tabl. 3). For the respondent age by sex, the mean year born for men was 1978, and median year born is 1979. For women, the mean year born is 1982 and median year born is 1983. When respondents' year of birth is pooled with both male and female, the overall mean year was 1980, and the median year of birth was 1982.

Table 3. Respondent sex proportions as compared to national rate. National rate is from the Polish National Statistical Office. Note that Poland does not report non-binary sex in demographic reported information. Percentages are rounded.

	Sample	Sample, excluding N/As and undisclosed	Poland (2024)
Male	24%	36%	48%
Female	42%	62%	52%
Other	1%	2%	
I prefer not to disclose/NA	32%	-	-

Key findings

At a high level, a majority of respondents felt that, in Poland as a whole, their local area, and all represented voivodeships, European bison populations were either the right size or too low (Fig. 2).

When we account for locality, being those respondents answering about the voivodeship(s) within their geographic cluster, we find similar results. The only voivodeship with a statistical discrepancy between the general public response and that without local input is Podlaskie (p-value = 0.004).

When we analyze according to gmina type, we find distinct urban-rural splits in opinion at local (Fig. 3), national (Fig. 4), and voivodeship levels (Fig. 5). In addition, we find unevenness by region, and when locality is taken into account, evidence of a general proximity split, though again with statistical significance only in Podlaskie.

Across datasets in general, though, where urban respondents consistently believe that populations are too low compared with other response options, rural and urban-rural respondents tend to have more even response distributions, though with majorities in each voivodeship except Podlaskie believing that European bison populations are too low as compared to being too high. This can perhaps be attributed to to the larger herd numbers of European bison in this area as compared to other places in Poland.

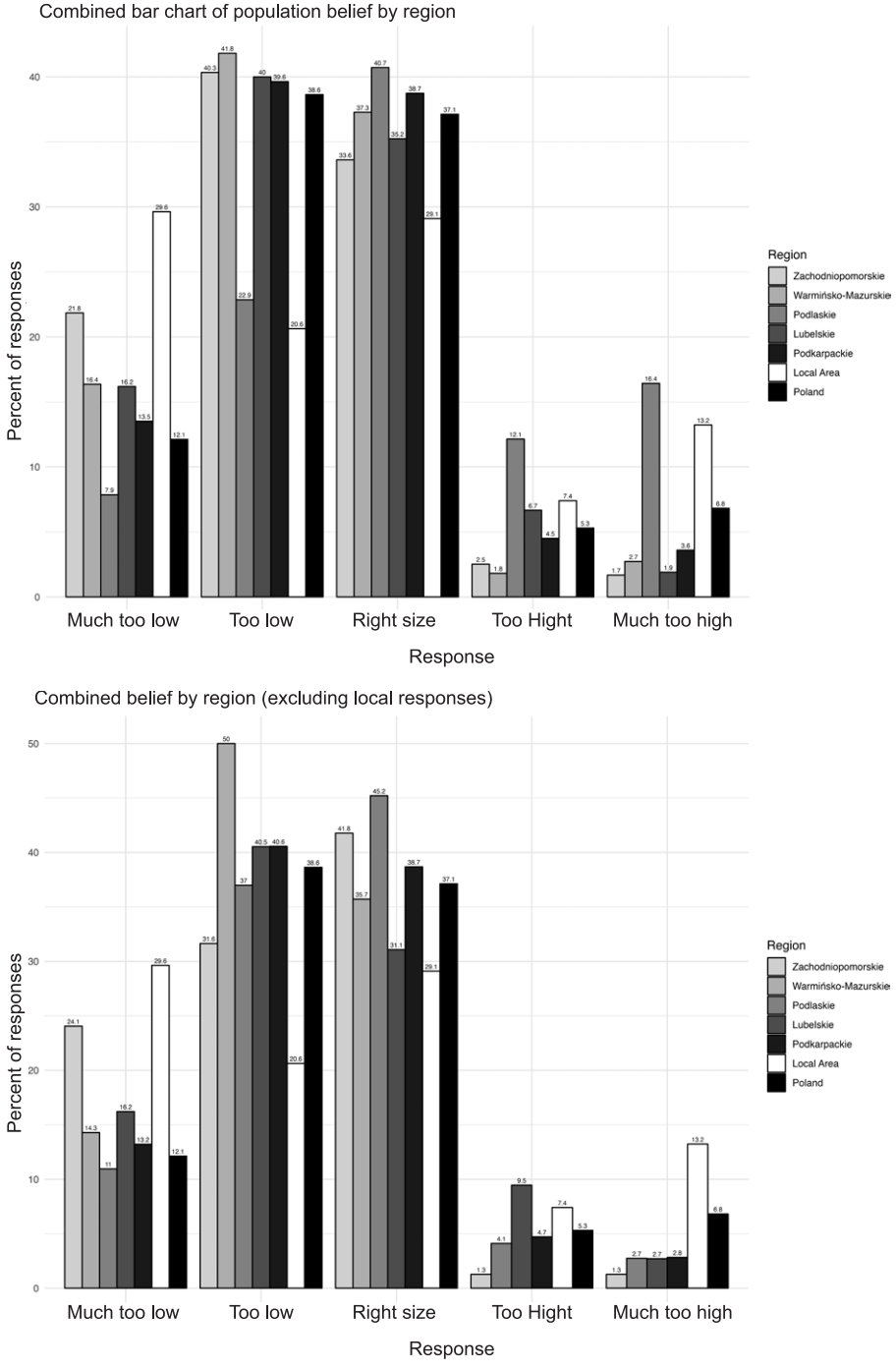


Figure 2. Total findings on European bison population sizes by voivodeship, local area, and Poland for all responses (upper), and excluding local responses (lower)

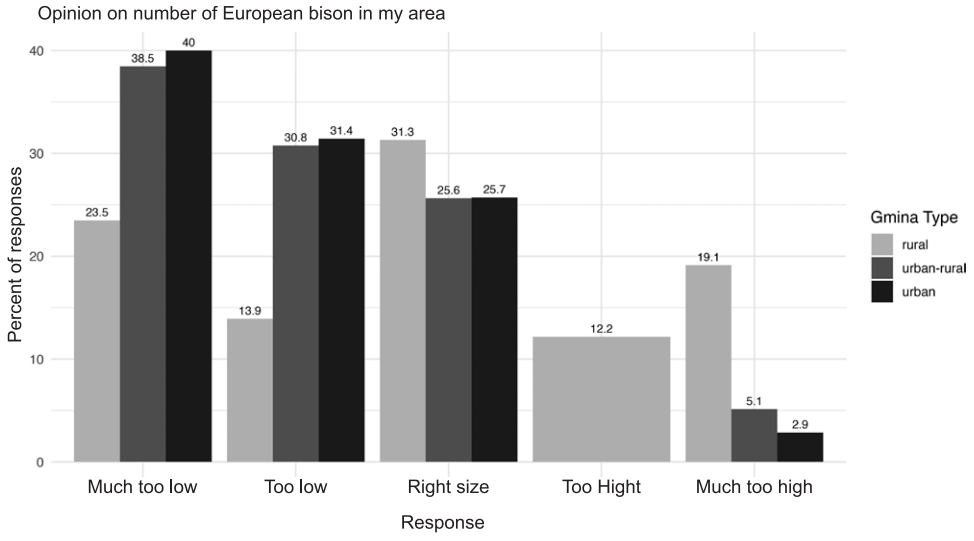


Figure 3. Respondents' opinions on European bison herd size in their local area by gmina type

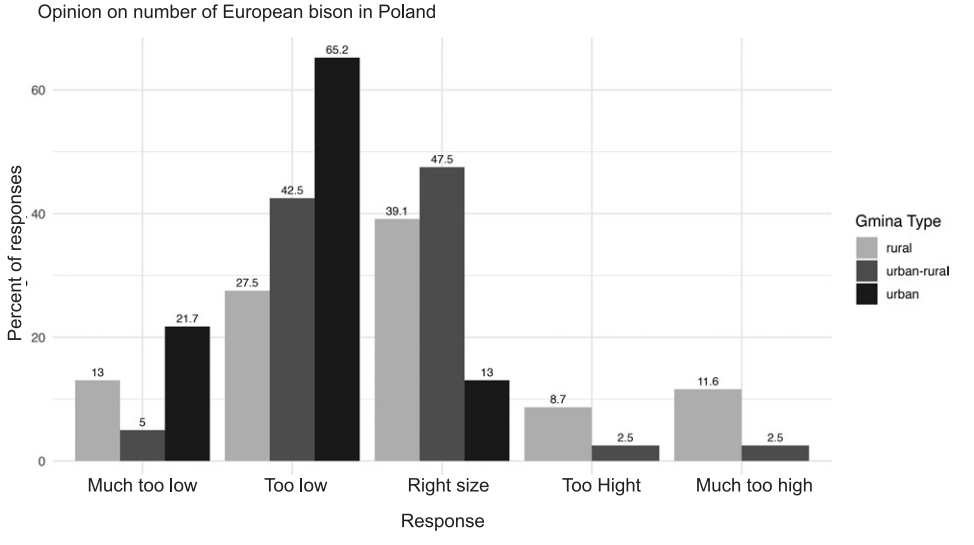


Figure 4. Respondents' opinions on European bison herd size in Poland by gmina type

These results corroborate previous regional findings from Podkarpackie by Klich *et al.* (2021), where geographic tolerance with an urban-rural social tolerance split, though it must be noted that 1:1 exact comparison with Klich *et al.* (2021) is not possible due to differing methodologies and urban-rural definitions.

Regardless, where Klich *et al.* (2021) found that 38.2% of rural respondents thought that European bison populations in their local area were too high, compared to 1% of urban respondents, we find that 31.3% of rural respondents and 5.6% of urban-rural respondents found populations too high, compared to 2.9% of urban respondents.

On the other hand, Klich *et al.* (2021) found that 57% of urban respondents thought that there should be more European bison in their local area, compared to 12.3% of rural respondents and 5.1% of urban-rural respondents. We find that 71.4% of urban respondents thought that there should be more European bison in their local area, compared to 37.4% of rural respondents and 69.3% of urban-rural respondents.

To determine the statistical significance of the urban-rural split with our sample, we conducted an ordinal logistic regression to analyze the effects of different gmina types on people's opinions about local, Polish, and voivodeship European bison population sizes.

We find that local population size opinion has a high significance in both urban-rural ($\beta = -1.187$; p-value < 0.001) and urban respondents ($\beta = -1.276$; p-value < 0.001). This suggests that people's opinions on local European bison population size are statistically strongly influenced by whether they live in an urban, urban-rural, or rural gmina. In contrast, for European bison population size opinion for Poland as a whole, we find that only the urban variable was significant ($\beta = -1.721$; p-value < 0.001), indicating that people's opinions on Poland's European bison population size differ based on whether they reside in urban or rural gmina, but not urban-rural gmina ($\beta = -0.3548$; p-value $= 0.334$). When we analyze opinions of populations in all voivodeships, only for Podlaskie and only for urban gminy do we see significance in population size opinion influence ($\beta = -2.144$; p-value < 0.001).

The odds ratios for local European bison population size opinion for urban-rural (0.305) and urban variables (0.279) both indicate that urban and urban-rural respondents are less likely to report that local populations of European bison are too high compared to rural respondents. For Poland European bison population size opinion, the odds ratio for urban-rural is 0.701, meaning that urban-rural respondents are more likely to rate the population as too high than rural respondents, though again, this result is not statistically significant. The odds ratio for urban respondents is 0.179, sug-

gesting that urban respondents are much less likely to report that populations are too high in Poland compared to rural respondents. For Podlaskie, the odds ratio is 0.12, again suggesting that urban respondents are much less likely to report that European bison populations in Podlaskie are too high as compared to rural respondents.

Discussion

First, our results indicate that across Poland, as well as in individual voivodeships and respondents' local areas, opinions along urban-rural divides are present and persist. While an aggregated majority of total respondents across contexts believe that European bison populations in all areas are either the right size or too small, there are still significant numbers of individuals who believe that populations in certain areas are too high. This indicates that perhaps certain herds, namely in Podlaskie, may be "indicator" herds for the Polish general public, by which the larger national European bison population is framed. The nationally historic visibility of herds in this area would also support this, with the Białowieska population specifically being perhaps the most poignant to individuals.

When we organize opinions by gmina type, our ordinal logistic model found that opinions on local population size are strongly influenced by location type, with rural respondents consistently rating the local population size as too high compared to urban and urban-rural respondents. This makes sense, as it is predominantly rural people who are coexisting with European bison upon shared landscapes and thus face interaction risks. Agriculture, forestry, and other rural economic activities have a higher chance for interaction with European bison than more urban economic activities by their very nature. Additionally, when a free-ranging species with such impact potential as the European bison even has a chance to come into conflict with or negatively impact such rural economic activities and thus rural livelihoods, a lower tolerance is a very reasonable outcome.

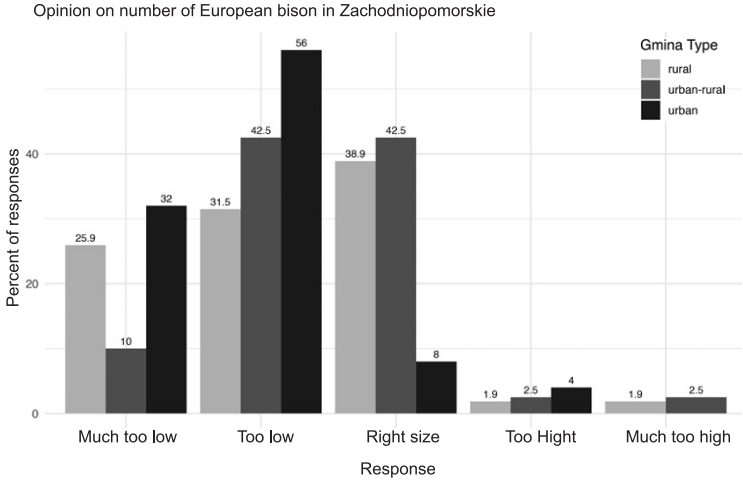
However, opinions on European bison population size in Poland at the national level are less influenced by location type, especially for urban-rural respondents, who do not significantly differ from rural respondents (Fig. 4). Why this distinction is present with this population specifically is uncertain. One potential explanation could be that urban-rural gmina economies and livelihoods are more similar to rural gmina economies than urban gminas, and thus are more similar in potential impact perception. This could perhaps be tested in future studies.

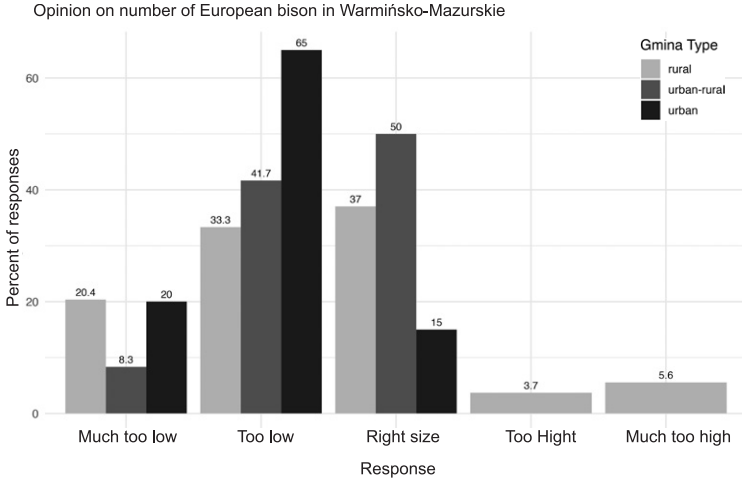
Furthermore, urban respondents consistently reported opinions of populations being either the right size or too low in Poland, as compared to rural respondents. This urban-rural split was also observed in Podlaskie voivodeship. The persistence of this urban-rural split creates a difficult situation for managers, who must balance the needs of those who are in some instances coexisting with, and most potentially impacted by, European bison (rural populations), with those who still hold an opinion on species management even though they are not sharing the same landscape in the same manner (urban populations).

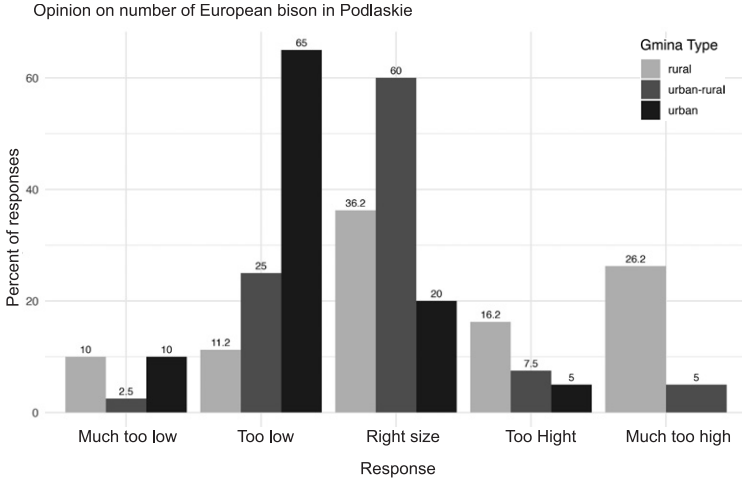
Next, when we compare results on population size opinion and account for local response influence, the only voivodeship with a statistical difference between the general public response and that without local input is Podlaskie (p-value = 0.004). This suggests that general proximity may be a key factor in opinions in Podlaskie, where those living closer to European bison herds have a statistically lower acceptable population size, believing more so than the general public that the populations are too large in Podlaskie. While the raw number is still less than that of locals believing that populations are either the right size or too small, it is an important distinction nonetheless, as future studies should continue to work to understand sources and influences of various factors on European bison population size beliefs and opinions.

Finally, our results corroborate regional findings on social tolerance of European bison from previous studies and additionally suggest that urban-rural divides are not isolated by region, but are indicative of wider urban-rural opinion divisions concerning European bison herd sizes in Poland. This indicates that European bison opinions may be more homogenously correlated to gmina type across Poland than one might assume. This homogeneity, too, may expand to other outcomes indicative of more nuanced measures in previous studies as well, such as farmer opinions, hunting acceptability, and management satisfaction.

In summary, the persistence of urban-rural divides in social tolerance of the European bison suggest that there are certain aspects of both rural and urban livelihoods that influence social tolerance. It is reasonably possible that direct negative economic and livelihood impact potential is most likely to depress tolerance in rural settings, and possibly a lack of direct impacts inflating said tolerance in urban settings. Additionally, this study supports the recommendation of previous studies that for managers to best align social tolerance with management population size goals, both rural and urban populations would benefit from education campaigns and outreach to best inform opinions. While rural populations are an obvious target population for such programs, it needs to be strongly emphasized that urban populations, though


Opinion on number of European bison in Zachodniopomorskie
Gmina Type
rural
urban-rural
urban
Percent of responses
0
20
40
25.9
10
32
31.5
42.5
56
38.9
42.5
8
1.9
2.5
4
1.9
2.5
Much too low
Too low
Right size
Too Hight
Much too high
Response


Opinion on number of European bison in Warmińsko-Mazurskie
Gmina Type
rural
urban-rural
urban
Percent of responses
0
20
40
60
20.4
8.3
20
33.3
41.7
65
37
50
15
3.7
5.6
Much too low
Too low
Right size
Too Hight
Much too high
Response


Opinion on number of European bison in Podlaskie
Gmina Type
rural
urban-rural
urban
Percent of responses
0
20
40
60
10
2.5
10
11.2
25
65
36.2
60
20
16.2
7.5
5
26.2
5
Much too low
Too low
Right size
Too Hight
Much too high
Response

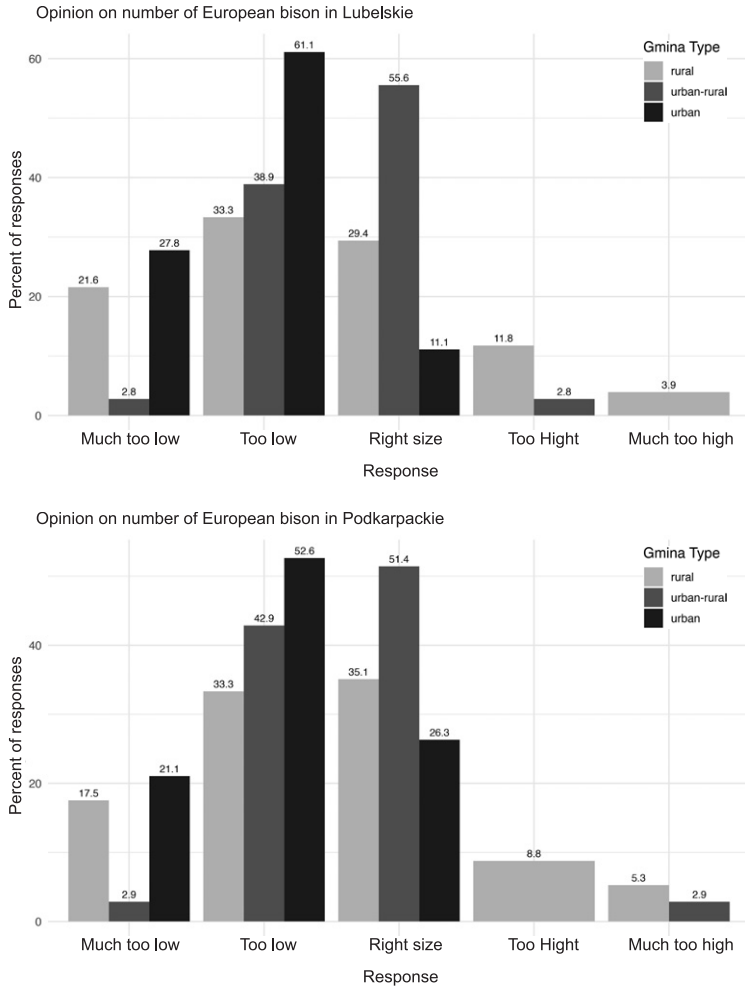


Figure 5. Respondents' opinions on European bison population size in each voivodeship by gmina type

non-proximal, are also a critical audience for education, even given their higher tolerance levels.

Even if it is assumed that the higher urban population social tolerance is more aligned with management goals, if such tolerance is derived from a lack of reliable information and experience, it runs the risk of ultimately undermining management goals by being vulnerable to inadvertently opposing effective management practices. To ignore urban population education is to assume that the status quo is not impacting rural people, though if it were not, their opinions would not differ.

Study Limitations

This study had several limitations, with the survey dissemination method resulting in few responses relative to the amount of gminy solicited and their respective population sizes. This could have been for a variety of reasons. First, after Russia's 2022 invasion of Ukraine, Poland has faced a surge in Russian cyberattacks, including those targeting local governments. (Government Plenipotentiary for the Security of Information Space of the Republic of Poland, 2022; CERT Polska, 2024; Reuters 2024; TVN24 2024). As a result, some email survey invitations may have been flagged as suspicious and ignored out of an abundance of caution, especially given local policies against interacting with external emails containing hyperlinks. Email exchanges with gmina administrators confirm such an outcome for several gminy.

Furthermore, the convenience sampling method meant that, when surveys were available, many participants had to chance upon the survey opportunity as not all were sent directly out to eligible participants. Instead, solicitation flyers were posted digitally on gmina administrative websites or hung in administrative offices. Therefore, unless sent directly to residents by the gmina office, it is likely that people who did not need administrative services could have missed or not been aware of the survey. In future studies, by utilizing a stratified random sampling method that does not rely on convenience factors and potential self-selection biases, sample sizes may be effectively expanded. Larger samples may uncover further insights, which can corroborate or counter the findings of this study, or provide more granularity to certain tolerance factors, which at this scale may not be significant.

Contribution and Recommendations

This study contributes to the wider literature by providing new insights into social tolerances and opinions of European bison in Poland. Urban-rural divides on tolerance and opinion persist within several stratified contexts, as well as based on proximity to major populations, notably in Podlaskie. However, these new findings raise additional questions that require further in-depth research.

First, the role and degree to which proximity impacts social tolerance and opinion needs further study, namely, at which proximities do tolerances and opinions begin to shift, and to what degree. Additionally, the root causes of tolerance and opinion need to be investigated, including how different experiences with European bison affect these metrics and how they feed into specific aspects of the intersection of wildlife acceptance and acceptability that con-

stitutes tolerance (Brenner & Metcalf 2020). Finally, a deeper understanding of tolerance nuances is critical to crafting impactful policy and management strategies to alleviate or prevent conflict.

By better understanding how tolerances are influenced or constructed, we can understand which core experiences or opinions are most influential. This can help inform more optimally designed management solutions (including education and outreach programs) to both prevent and resolve human-wisent conflicts. Deeper insights into European bison social tolerance has an opportunity to increase sustainable coexistence and allow socially-appropriate population sizes to be more closely aligned with biological carrying capacity, maximizing European bison ecological engineering and keystone species benefits where applicable, thus improving overall European bison wildlife management and coexistence.

Conclusions

Human social tolerance is a critical component for successful conservation outcomes and, in the case of the European bison, is understudied in comparison to species biology and biophysical development. By asking Poles their opinions on the size of free-ranging European bison herds, we find that a majority of Poles believe that European bison herd sizes across geographic contexts are either at the right size or are too small. We find statistically significant correlations between respondent gmina type (rural, urban-rural, urban) and European bison population size opinions in local and national contexts, as well as specifically in Podlaskie voivodeship. Moreover, in Podlaskie we find a statistically significant response difference between individuals living in northeastern Poland and the general public, indicating that there may be additional proximity factors unaccounted for in this study that influence social tolerance. These multiple findings raise further questions on opinion and tolerance development. Further research in this area can provide critical insight into potential wider challenges and opportunities Polish wildlife managers face in managing social tolerance of locals to European bison, and thus overall wildlife coexistence and conservation outcomes for the species as a whole.

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Zróżnicowanie opinii mieszkańców gmin miejskich, wiejskich i miejsko-wiejskich na temat liczebności populacji żubra (*Bison bonasus*) w Polsce

Streszczenie: Zrozumienie tolerancji społecznej jest kluczowe dla skutecznego zarządzania dziką fauną oraz kształtowania polityki ochrony przyrody. Dzięki temu możliwa jest harmonizacja biologicznej pojemności środowiska i społecznie akceptowalnej liczebności populacji, a w efekcie poprawa efektów ekologicznych oraz koegzystencji ludzi i dzikich zwierząt. W niniejszym badaniu analizowano tolerancję społeczną wobec żubra (*Bison bonasus*) na podstawie opinii mieszkańców wybranych regionów Polski na temat liczebności populacji tego gatunku. Na podstawie badania ankietowego ustalono, że zdaniem większości respondentów liczebność populacji żubrów w ich lokalnym otoczeniu, województwie oraz w całej Polsce jest odpowiednia lub zbyt mała. Jednocześnie zaobserwowano istotne różnice między opiniami mieszkańców gmin wiejskich, miejskich i wiejsko-miejskich. Analiza regresji logistycznej porządkowej wykazała, że typ gminy (wiejska, miejska lub wiejsko-miejska) istotnie wpływa na ocenę wielkości populacji. Stwierdzono, że mieszkańcy miast częściej uważali populacje za zbyt małe, podczas gdy mieszkańcy wsi częściej oceniali je jako zbyt duże. Różnice te były istotne statystycznie zarówno na poziomie lokalnym ($\beta = -1{,}276$; $p < 0{,}001$), krajowym ($\beta = -1{,}7212$; $p < 0{,}001$) jak i w województwie podlaskim ($\beta = -2{,}144$; $p < 0{,}001$). Ponadto województwo podlaskie okazało się jedynym województwem, w którym odpowiedzi mieszkańców istotnie różniły się od opinii ogółu społeczeństwa ($p = 0{,}004$) co może sugerować dodatkowy wpływ bliskości populacji żubrów na poziom tolerancji społecznej. Uzyskane wyniki są zgodne z wcześniejszymi badaniami dotyczącymi tolerancji społecznej wobec żubra i potwierdzają jej zróżnicowanie wśród mieszkańców obszarów wiejskich i miejskich. Badanie to poszerza wiedzę na temat tolerancji społecznej wobec żubra w Polsce oraz otwiera perspektywy dla dalszych badań. Przyszłe analizy powinny skoncentrować się na mechanizmach kształtujących wzorce tolerancji społecznej, uwzględniając szczegółowe doświadczenia mieszkańców oraz dodatkowe zmienne wyjaśniające, które wpływają na bardziej zniuansowane wskaźniki postaw i społecznej akceptowalności.