Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Natural Sciences
Department of Biology

Per Henrik Rishøi

The socio-ecological impacts of the invasive house crow (Corvus splendes) in Tanzania

Master's thesis in Natural Resources Management, Biology
Supervisor: Eivin Røskaft
Co-supervisor: Augustine Arukwe, Peter Sjolte Ranke, Franco Peniel Mbise, Kwaslema Malle Hariohay

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1 Abstract

Invasive species is one of the greatest threats to biodiversity. Local knowledge and attitudes of invasive species can help understand the impact they have on the environment. By uncover the general public's perceptions it could become easier to deal with the issue. As an invasive species may have less natural competitors, which may enable rapid increase of their home range, affecting both people and biodiversity. The main finding of this study suggest that the perception of Indian house crows may have been affected by their rapid change in distribution and in numbers. People in Dodoma and Morogoro have the most knowledge and more negative attitudes towards house crows. The rapid changes and close proximity to humans may be the reason for the negative attitudes. Even though house crows have been in the coastal areas for more than 120 years, people seem to have the least negative attitudes, and knowledge at the same level as the cities were house crows are barley present. People with a higher level of education seem to have more negative feelings about house crows, but formal education was less important for bird identification. Those with with higher education were able to reflect on the effect house crows could have on biodiversity, and that it would be benefits to exterminate them. Therefore it is recommended that education about house crows in the general public, so Tanzania could reduce the spread of house crows in Africa.

Key words: House crow, invasive species, attitudes, knowledge, Tanzania

2 Sammendrag

Invasjonsarter er en av de største truslene for biologisk mangfold i naturen i dag. Lokal kunnskap og holdninger til invasjonsarter kan bidra til å forstå hvilken påvirkning de har på miljøet. Ved å avdekke allmennhetens oppfatninger kan det bli lettere å håndtere problemet. Ettersom en invasjonsart kan ha mindre naturlige konkurrenter, kan dette føre til at de raskt øker utbredelsesområde sitt, noe som påvirker både mennesker og biologisk mangfold. Funn tyder på at oppfatningen av huskråken er påvirket av dens raske økning i utbredelse og antall. Folk i Dodoma og Morogoro har mest kunnskap og mer negative holdninger til huskråker. De raske endringene av antall kråker i området kan være årsaken til de negative holdningene. Selv om huskråker har vært i kystområdene i mer enn 120 år, ser det ut til at folk har mindre negative holdninger, og kunnskap er på det samme nivå som byene hvor huskråker så vidt har etablert seg. Personer med høyere utdanning ser ut til å ha mer negative følelser for huskråker, men utdanning var mindre viktig for kunnskapsnivået folk hadde. Folk med høyere utdanning var generelt bedre på å reflektere over effekten huskråker kunne ha på biologisk mangfold, og at det ville være fordeler å utrydde dem. Derfor anbefales det å etablere et undervisnings program om huskråker i befolkningen, slik at Tanzania kan redusere spredningen av huskråker i Afrika.

Nøkkelord: Huskråke, invasjons arter, holdninger, kunnskap, Tanzania

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Asante sana!

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5 List of Abbreviations

AIC . . . Akaike information criterion

GLM . . . Generalized linear models

SPSS . . . Statistical Package for Social Science

6 Introduction

6.1 Biology

Invasive species is one of the major threats to loss of biodiversity today. An invasive species is an organism introduced to a new environment it has not previously occupied, often trough assistance of humans, either intentionally or unintentionally (Primack, 2014). The arrival of invasive species to an environment can be detrimental and cause harm for biodiversity and for humans. One of the biggest reasons why invasive animals threatens biodiversity is because they are able to establish easier in new areas and modify the ecosystem(Simberloff, 2010). Not just change the physical environment, but also the dynamic between the native species. Invasive animals will compete with native species for resources. By consuming native species there will be less of resources as well as higher level of competition among the native species. Since none of the native species has evolved along with the invasive species they have less defense mechanisms making them more vulnerable for predation (Doherty, Glen, Nimmo, Ritchie, & Dickman, 2016; Doherty, Dickman, Nimmo, & Ritchie, 2015). There will also be less competition and predators to keep the population of the invasive species in balance. Leading to invasive species being able to rapidly reproduce and outcompete the native species. With some native species reduced in numbers some ecosystem services may be diminished or completely gone (Mooney & Cleland, 2001). Invasive species might also carry diseases and pathogens threatening the local biodiversity and humans. Without any form of protection or immunity against the disease the effect might be much higher in the local species than in the invasive host (Crowl, Crist, Parmenter, Belovsky, & Lugo, 2008). Since invasive species is identified as one of the main threats to loss of biodiversity (Primack, 2014) invasive species is seen as a negative thing. But earlier research has been heavily focused on ecological effects of invasive species, focusing less on the general public's knowledge and attitudes towards invasive species (Kapitza, Zimmermann, Martín-López, & von Wehrden, 2019). Management of urban wildlife conflicts need to include the public and biologists. The exclusion of the general public's attitudes from management can create a gap between management and stakeholders. Understanding the perceptions towards invasive species requires people's perspective as they can have totally opposing views. Communities can perceive invasive species as positive if they contribute socio-economic value (Fischer, Selge, Van Der Wal, & Larson, 2014). Neglecting the local perspective can led to resistance and opposing management measures (Woodford et al., 2016). Therefore, the purpose of this study was to understand the current knowledge, and attitudes towards house crows in Tanzania.

The house crow *(Corvus splendens)*, is one of the most invasive birds in the world (GISD, 2007) also known as the Indian, Grey necked or Colombo Crow. the house crow, is an invasive species in Tanzania, and originates from Asia. The house crow's native range spans from south-east Iran up to Nepal, to Thailand in the east (Madge & Burn, 1994; Hoyo, Elliott, & Christie, 2009). The Indian house crow is among the 133 other species in the Corvid family. Often recognized by, but not limited to dark colours of gray and black on their plumage. The house crow has a slender body approximately 40 cm from head to tail (GISD, 2007; Hoyo et al., 2009) Currently this species has spread to many parts of the world, often by joining ships to other coastal cities (Ryall, 2016). In the 1890s the crow was introduced deliberately to Zanzibar to reduce the loads of garbage (Long, 1981). This could have been a valuable ecosystem service since they could reduce the amount of waste that would have accumulated (Anjum, Ahmad, Bibi, & Ali, 2021), However, the crows may have already imposed significant negative impact on the native species on Zanzibar. From there it rapidly spread along the coast of East Africa and was already in 1917, officially declared a pest (CABI, 2009; Ntapanta, 2023). Tanzania has been experiencing

massive growth in the house crow population, particularly in the coastal areas like Dar es Salaam, Tanga and on Zanzibar. The population of house crow has increased rapidly because of its ability to adapt to new environments, because of suitable nesting sites, improved food availability, and the lack of natural predators and competition (Vuorisalo et al., 2003). Since 1997 it started spreading to more inland areas such as Morogoro, and further to Dodoma since 2000 (Shimba & Jonah, 2017). It is hypothesised that the crows may have spread to these areas through human activities, such as transportation and along roads and railways (Saiyad, Soni, & Radadia, 2017; Chakraborty, Das, Ash, Saha, & Aditya, 2020).

Many members of the Corvid family are recognized as intelligent animals, often compared with -dogs, dolphins, chimpanzees and young children. Reasons for this are the ability to construct tools, solving complex puzzles, remembering for longer periods of time, and their ability of social learning (Cornell, Marzluff, & Pecoraro, 2012). One of the reasons for their intelligence is the brain to body ratio (Fabre, Irestedt, et al., 2012). This is exemplified by the New Caledonian crow *(Corvus moneduloides)* which is recognized as the most advanced user of tools by all members of the bird class (Kenward, Weir, Rutz, & Kacelnik, 2005; Jønsson, Fabre, & Irestedt, 2012). The relative big brain size compared to body size makes the house crow able to adapt to different environments (Sol, Duncan, Blackburn, Cassey, & Lefebvre, 2005). Crows are well suited for urban areas since they have good abilities to find food and a generalist diet. With the ability to eat huge variety of different food combined with its opportunistic behavior, makes the crow less picky about their environment, giving them the ability to populate new territories and surviving (Soulsbury & White, 2015). Adapted to live in densely populated areas in India, house crows have evolved an opportunistic behavior that drives it closer to humans, to exploit anthropogenic areas and feed on left overs humans do not eat (Ryall, 1992; Nyari, Ryall, & Townsend Peterson, 2006; Wilson, Sarim, & Rahman, 2015). Due to human population growth in eastern Africa the house crows have been enabled to multiply and expand its range in Tanzania. The crows have been able to disperse further inland more easily among cities because the road network has been improved, being more complex and since cities has expanded making the distances between cities shorter. Since the presence of humans drives many species out of areas, this also opens up the possibility for the crows to establish themselves, as there are fewer competitors (Primack, 2014). As an introduced invasive species, this species has the ability to spread, posing a threat to native biodiversity, as well as the health of domesticated plants, animals, and people. (Simberloff, 2010). The increase in distribution and abundance is by itself a threat and should be considered a conservation concern. Moreover, it extensively feed on local biodiversity such as invertebrate, small mammals, reptiles, amphibians and carcasses. Indigenous birds are also negatively impacted since crows raids nests of passerine birds for eggs and chicks (Suleiman & Taleb, 2010). Direct competition with lager birds is observed by persistent harassment and mobbing (Long, 1981; Ryall, 1992), often resulting in the native bird abandon their food (Yosef, Zvuloni, & Yosef-Sukenik, 2012).

House crows are highly dependent on anthropogenic food sources and show little fear towards humans, entering buildings, scavenging on human waste and steal food, dive bomb, and snatch food directly in front of humans (Wilson et al., 2015; Lim, Sodhi, Brook, & Soh, 2003). Crows also affect agriculture by feeding on crops of fruit and grains grown by farmers (Puttoo & Archer, 2004; Kamel, 2014). Domestic poultry are frequently attacked and preyed on especially smaller chickens and egg (Ryall, 2010).The growing population of house crows thereby is leading to significant economic loss for farmers (Dhindsa, Sandhu, Saini, & Toor, 1991; Akram, Khan, Javed, et al., 2013).

These crows are also a health hazard carrying diseases and bacteria from carcasses, their excretes might spread diseases polluting human food and water sources (CABI, 2009). Their omnivorous behavior on

dumpsters makes them potential spreaders of diseases such as typhoid, cholera and various prion diseases such as scrapie and chronic wasting disease (O'Connor & van Wilgen, 2020), thereby indirectly causing economic losses.

To enhance the effectiveness of bird management, it is crucial to have support from the general public. Wildlife management must consider social attitudes and economics to ensure that strategies involving stakeholders are viable for success. As the species has a detrimental potential on local biodiversity, Tanzania must improve their management of house crows (Kamel, 2014). The cities of Dar es Salaam, Morogoro, Tanga, and Zanzibar in Tanzania are currently home to millions of house crows, causing the Tanzanian society a cost of trillions of shillings (Fraser, Aguilar, Nagle, Galbraith, & Ryall, 2015; Ryall, 2016). The authorities of Tanzania have seen the potential threat of house crows to invade inland Africa, potentially threatening protected areas like Lake Victoria, Mikumi, Ruaha, Tarangire, Mkomazi, Lake Manyara, Serengeti national park as well as Maasai Mara nature reserve in Kenya (Ndimuligo, Mbwambo, Kavana, & Nkwabi, 2022). If house crows are freely allowed to expand their distribution the subsequently effect on biodiversity and socio-economic losses could become huge, potentially affecting the tourism industry in Tanzania (Morrison, 2012). If the house crow starts to invade protected areas two scenarios might play out; either the native birds and predators prevents the house crow population to grow and establish in the national parks, or the crows succeed in invade and starts to prey on native birds and eat leftovers around safari camps.

It is important that the Tanzanian government Tanzania develops effective management plans to reduce the numbers of house crows. Population reduction in house crow numbers have shown to be difficult and a more effective management will require a different approach. However, such labor intensive population management needs sustainable funding sources. Moreover, improved waste management and education of public waste disposal will be beneficial, since garbage is one of the main food sources for house crows in cities (Wilson et al., 2015). The knowledge about the effects on humans is still lacking. It is difficult to reduce the number of crows due to this as they quickly learn to avoid traps, poison and shooting. As an alternative the general public could be implemented to reduce the number of crows. It would therefore be beneficial to assess the general public's knowledge and attitude, so further management could be implemented.

6.2 Perception

Crows and ravens are often conflated with one another in folklore and religion. As they are depicted as symbols, they are often used interchangeably depending on translations of different religious texts. Corvids are found on all continents except Antarctica. Due to similar characteristics, lack of knowledge and close relatedness are some of the reasons why they are used as similar symbols throughout time. Therefore, the perception of crows goes hand in hand with the depiction of ravens. Humans in general regard corvids as highly intelligent creatures (Marzluff, Walls, Cornell, Withey, & Craig, 2010), but trough out time corvids have also been seen as bad omens and as representants of death. As many of the species are opportunistic and omnivorous, they can easier adapt to changes than specialist species(Clavel, Julliard, & Devictor, 2011).Because of these traits, corvids have lived side by side with humans and been implemented in our stories. In both religion and folklore from around the world, crows and ravens are seen as mythical creatures, often associated with the darkness and something negative. This can be explained by their omnivorous behavior as well as they often prey on carrion. Especially after combats and wars corvids were present to feed on the dead. The close association with death and for their level of intelligence they have been seen as messengers between the death and living (Król & Hernik, 2020).

Today crows are often seen eating waste and leftovers from humans instead, still crows are regarded as carriers of potential disease. Many of the perceptions and beliefs of corvids share similar characteristics across continents. This may root in a common understanding of the biology of the bird. In all the major religions crows and ravens are specified not to be eaten, along with many other animals. This might stem from their omnivorous feeding habit to avoid people getting diseases and the stigma around them as birds.

In Norse mythology the god Odin possessed two ravens with the name Huginn and Muninn, translated from Old Norse means "thought" and "memory". Names like this can provide us with some evidence that people regarded these creatures as intelligent for a long time. Their job was to work as Odins eyes across Midgard and bring back the information to him. In Greek mythology, corvids were associated with the Apollo, the god of oracles. Here they were the messengers from the gods to the material world and they came with bad luck. Crows and ravens are also mentioned twelve times in the bible (Bible, 1987). In the Qur'an ravens are associated with death, it is said to have learned Cain how to bury the corpse of Abel (Qur'an 5:31). Current day media continue to use corvids as symbols often in the same way as before, by using them as messengers between worlds, mythical and as intelligent creatures. Almost no research focuses on attitudes towards invasive birds have been done and is still lacking (Kapitza et al., 2019).

6.3 Objective

The aim of this thesis is to test the public attitudes and knowledge towards the invasive Indian house crow in Tanzania. Furthermore, I wanted to test their knowledge about the time the crow has been present in their city or if it affects their daily life. The results will give us an understanding of how well the general public know this invasive house crow or if education of the public is needed.

6.4 Hypotheses

I will test the following hypotheses:

H1, The public knowledge about the Indian house crow is better in coastal cities where people have a long history with this invasive bird. In inland cities where the history with this bird is shorter people's knowledge will be poorer.

H2; Public attitudes towards this invasive species is more negative where knowledge is better. Alternatively, in inland cities where knowledge is poor, attitudes are also more positive or neutral.

6.5 Predictions

It was predicted that:

P1: People with higher education will have a stronger negative view towards house crows.

P2: People with higher education will have a stronger negative view on the impact of local biodiversity of house crows.

P2: People who are from coastal cities where they have a long history with the house crow, have more knowledge and more negative attitudes towards house crows.

7 Materials and methods

7.1 Study areas

Tanzania is situated in East Africa right below the equator, with a population of approximately 63 million people, and is home to over 130 ethnic groups who speak more than 100 different languages (Lawrence, 2009; The World Bank, 2022). Swahili is the national language, and English has become increasingly common. The country has a land area of 947 303 km^2 and borders the Indian Ocean. The coast has made it an important hub for trade with India and Britain.

The study was conducted in seven major cities in Tanzania, specifically in these seven cities: Arusha, Moshi, Tanga, Dar Es Salaam, Morogoro, Dodoma, and Singida (Figure 1). These cities were chosen based on several factors, but mainly based on the timeline of the dispersal of the house crow. To cover areas where crows were first introduced, where they had been present for some decades and were they where barley present. The cities also had to be somewhat similar in size. Additionally, the selection of these cities aimed to represent a diverse group of people who could potentially be affected by the presence of house crows.

Dar es Salaam and Tanga are two of the major coastal cities in Tanzania, where house crows have been present for over a century. The crows are believed to have been introduced to Tanzania through transportation and trade with India. Dar es Salaam is the largest city in Tanzania with a population of over 6 million people. Tanga is located north of Dar es Salaam, and is another major port city in Tanzania where house crows were first established. These two cities were therefore classified as cities with long presence of house crow.

During the past three-four decades, the house crow has also been observed in more inland cities, including Morogoro and Dodoma. Morogoro is a city located in the eastern part of Tanzania. It has a population of around 300,000 people and is an important center for agriculture and education. Dodoma is the capital city of Tanzania and is in the central part of the country. It has a population of over 410,000 people and is an important administrative and political center. Here house crows have been seen for more than 20 years, and older people have seen the establishment of the species and these cities were grouped as the cities with medium history of house crows present.

Singida, Arusha and Moshi are cities with the shortest history with house crows. Arusha, Moshi lays close to the Kenyan border with a cooler temperature. Singida is situated along the Mwanza- Dodoma highway and serves as a transit point for people travelling between these two cities. In Singida, Arusha and Moshi the house crow is reportedly not very common in the cities as the cities are located further inland and at higher elevations. However, there have been sightings of the crows in these areas in recent years. Therefore, these cities are grouped into the cities with the most recent history with house crow.

7.2 Sampling

In the field study 316 questionnaires were conducted among the general public in the six cities in Tanzania. The target was to obtain responses from 50 participants in each city, but the actual number of respondents varied from 30 to 56, leading to a total of 316 questionnaires answered. The study utilized the socioeconomic data as following, city, gender, age, tribe, education, occupation, residency. To gather data the participants answered the questionnaire (Appendix 1). People was randomly selected on the street near the town center. The questions were conducted by a Tanzanian assistant who had previously worked with questionnaires in Tanzania, and thus, was able to bridge any cultural gaps. The assistant

conducted the questionnaire to avoid influencing the responses. The questionnaire was well explained to the assistant beforehand to avoid misunderstanding during the study without interfering. No changes were made to the questionnaire during the field study.

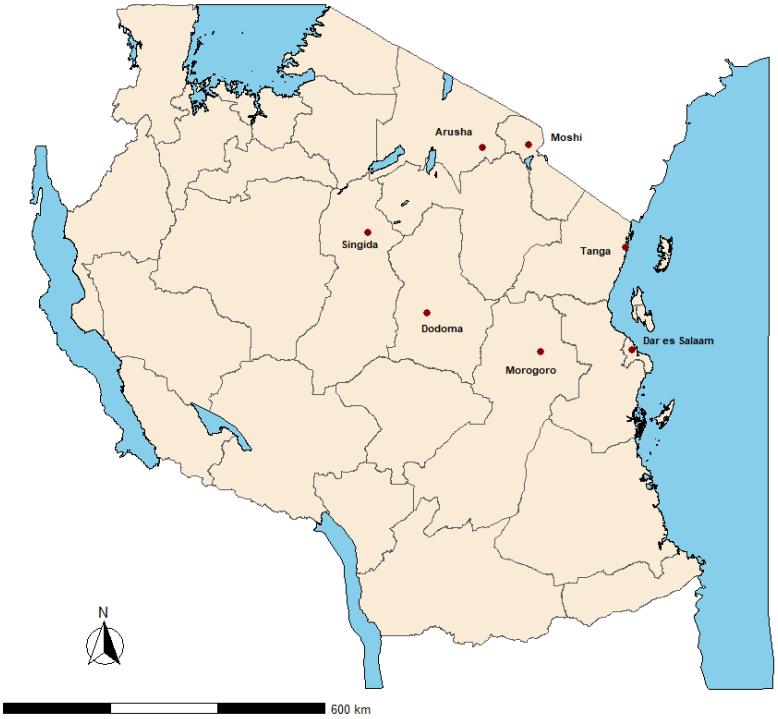

Figure 1: Tanzania with the seven cities where the questionnaire was conducted marked with red dots. Arusha, Moshi, Singida, Morogoro, Dodoma, Tanga & Dar Es Salaam

7.3 Characteristics of respondents

There were 316 respondents in total; as far as possible a representative group of Tanzanian inhabitants were questioned, with an equal gender distribution. 51.7% of the participants were males, and 48.3% of the participants were females. Responders varied from 16- to 67-years-old. Most respondents were between 26-35 years old (38.0%) with the average age of the participant being 35 years old (SD = 10,13,N = 314), followed by 26.9% between 36-45 years, while 19.0% belonged to the age group below 25 years, while respondents above 46 years were the remaining 15.5%. The most common level of education among the respondents was primary school (34.4%), closely followed by 28.7% who had completed secondary school and 19.7% who had preceded above secondary school. 17.2% had no education at all. 31.7% of the respondents worked in the private sector, 17.1% were farmers, while only 7.3% worked for the government, finally, 24.1% were involved in other occupations and 19.7% had no job at all. Since so many were included in the "other" occupation group, the occupation variable was not used in the analyses. Respondents were from over 50 different tribes.

Table 1: Summary of characteristics of respondents from the seven different cities in Tanzania

Variables (n = 316)	Cities in Tanzania							
	Arusha n=30	**Moshi n=50**	**Tanga n=45**	**Dar es Salaam n=40**	**Morogoro n=42**	**Dodoma n=52**	**Singida n=56**	**Total (%)**
Gender								
Man	56,7%	50,0%	37,8%	50,0%	54,8%	62,3%	50,0%	51,7%
Woman	43,3%	50,0%	62,2%	50,0%	45,2%	37,7%	50,0%	48,3%
Age								
16-25	10,0%	10,0%	9,1%	30,8%	21,4%	35,8%	14,3%	19,0%
26-35	40,0%	42,0%	54,5%	38,5%	26,2%	28,3%	39,3%	38,0%
36-45	26,7%	26,0%	27,3%	23,1%	31,0%	18,9%	35,7%	26,9%
46+	23,3%	22,0%	9,1%	7,7%	21,4%	17,0%	10,7%	15,5%
Education								
None	36,7%	28,0%	35,6%	7,9%	4,8%	5,7%	8,9%	17,2%
Primary school	36,7%	44,0%	48,9%	28,9%	50,0%	17,0%	21,4%	34,4%
Secondary school	23,3%	26,0%	15,6%	26,3%	40,5%	35,8%	30,4%	28,7%
Above secondary school	3,3%	2,0%	0,0%	36,8%	4,8%	41,5%	39,3%	19,7%
Occupation								
None	10,0%	14,0%	46,7%	17,9%	0,0%	34,0%	10,7%	19,7%
Farming	20,0%	24,0%	6,7%	5,1%	4,8%	17,0%	35,7%	17,1%
Governmental	0,0%	2,0%	2,2%	2,6%	4,8%	9,4%	23,2%	7,3%
Private	56,7%	44,0%	37,8%	53,8%	4,8%	7,5%	30,4%	31,7%
Other	13,3%	16,0%	6,7%	20,5%	85,7%	32,1%	0,0%	24,1%

7.4 The Questionnaire

In the first part of the questionnaire the participants were requested to provide general information about themselves, including their gender, age, tribe, education level, occupation and where they lived. The questionnaire comprised a total of eighteen questions that aim to gather information about house crows. These questions cover topics related to knowledge about house crows, such as their identification and about its invasiveness. Additionally, the questions covered the participants' attitudes and perceptions towards house crows, as well as their level of knowledge and awareness about these birds (Appendix 1). The initial two questions were posed to determine whether individuals could recognize the house crows or not. The respondents were shown pictures of a pied crow and a house crow. This choice was based on the fact that house crows and pied crows share similar features, found in near proximity of human settlements, and share a similar niche. The next three questions were asked to assess whether the participants were aware that the house crow is an invasive species or not, and if house crows belongs to Tanzania. The following questions focused more on attitudes and if respondent were affected in their daily life by house crows. The final section of the questionnaire tried to explore more intricate questions. Where the knowledge about house crows could potentially influence the respondents' attitudes towards them.

7.5 Data Sorting and Cleaning

Of the 316 questionnaires answered, not all participants answered all the questions. Hence the sample sizes vary in the statistical analyses. A threshold was established to deal with missing data. If too few had responded to a question, the question was skipped. In all questions where the respondent was supposed to rate something a statement on a Likert-type scale from 1-5, either going from "strongly agree", "very positive" etc. to "strongly disagree", "very negative" were converted to a scale of 1-3. Responses "very positive" and "positive" were grouped as well as "very negative" and "negative". During the data sorting cities where house crows have been observed for a similar time period have been merged to increase the strength of the statistics. In the analyses cities with approximately the same history of house crow presence were merged. Arusha, Moshi and Singida were merged, where the house crow is barley present, and renamed "recent" time. Tanga and Dar es Salaam were the cities where house crows were first observed about 130 years ago and where they were first observed in the mainland Tanzania "long" time. These two cities therefore have the longest history with the presence of Indian house crows. Finally, Morogoro, Dodoma has had house crow for about 20-25 years which was classified as "medium" time.

7.6 Analysis and Statistics

The statistical analyses were conducted using Rstudio (R version 4.3.0 2023) and Statistical Package for Social Science (SPSS version 29). To understand the data, descriptive statistics were performed on the categorical data. All questions were run through Chi-square tests to reveal any difference in the distribution between the variables. The "knowledge" variable is the aggregate of three questions regarding the identification of house crows. Thus, all questions answered correctly would result in three points, whereas none would result in zero. Thereafter the mean, of the knowledge was tested with an ANOVA test. A Kruskal-Wallis test was conducted, for comparing the distributions of the knowledge variable among location and education. Similar to the "knowledge" aggregation, the "attitude" and "Knowledge-based attitude" variables were treated similarly, based on three attitude questions, and three knowledge demanding attitude questions respectively.

Generalized linear models (GLMs) were used to determine the relationship between the variables and knowledge, attitude and knowledge based attitude. Fitted using the Gaussian distribution function to determine the relationship between "knowledge" and the socioeconomic predictors; city, gender, age, education and occupation (Brooks et al., 2017). The models were compared using the Akaike information criterion (AIC). AIC selects the model that explain most variation using the lowest number of independent variables or degrees of freedom to be the best model. A threshold for the delta(Δ) value was set to less than 2.00. Additional GLMs were fitted to analyze the relationship between "attitude" and "knowledge-based attitude" and the predictors.

8 Results

8.1 Knowledge

From Question 1, “What bird is this?” were the respondents were showed a picture of a pied crow showed that 22.2% (n=316) of the respondents were able to identify pied crows correctly. The responses "pied crow", "white crow", "kunguru" were accepted as correct. While 30.7% were able to partially identify the pied crows, by answers such as “crow”, or “white house crow”. The remaining 47.2% of people were not able to identify pied crows at all. Either by answering blank, name a different bird or they did not know the bird. Women were slightly better at identifying pied crows than men. People with higher education was better at identifying pied crows. People in Arusha, Moshi and Singida was much better at identifying pied crows (41.2%) than any other the other cities (12.6 % and 2.6%) (Appendix 2).

In regards of Question 2, respondents were shown a picture of a house crow, with the question “What bird is this?”. The answers showed that 56.0% (n=316) of people were able to identify house crows by the correct name. Both "House crow", " and "Indian house crow" were accepted as correct names. The 25.0% of respondents were able to partially identify the crows, by answers such as “crow”, "black crow" or similar answers. 19.0% of respondents across Tanzania were not able to identify house crows at all. Either by answering blank, wrong bird or they did not know the bird. Only variation was withing the variables education, occupation and city differed statistically significant (Appendix 3). People became better at identifying house crow with increase level of education, except respondents with the highest level of education. They were worse at identifying house crows than any other level of education. People from Dodoma and Morogoro was much better (84.2% correctly identified) at identifying house crows than any other places (34.6% and 58.8%) (Appendix 3). Overall, Tanzanians had a much higher success-rate at identifying house crow compared to pied crows, indicating that people were much more aware of house crows.

When asked the question "Is this Indian house crow a bird that belongs to the Tanzanian nature?", 19.2% (n=313) answered that the house crow did not belong to the Tanzanian nature, 53.0% were not sure. While as many as 27.8% though that house crows belong in Tanzania. With increased education level respondents were less likely to answer, "I don’t know" and would rather answer yes or no. Uncertainty was more apparent in people with lower levels of education. Respondents in the central cities had a stronger opinion if house crows belonged in Tanzania or not. In the two other areas respondents were more likely to answers i don’t know. However, people from the coastal cities were less likely (12%) to say house crows belonged in Tanzania (Appendix 4).

To the Question “Do you know what an invasive species is” showed that 46.5% (n=297) knew what an invasive species is. Education, occupation and location differed statistically significantly on this knowledge question (Appendix 5). There was a significant correlation with education level and if the respondents knew what an invasive species was. People with higher level of education were more likely to know what an invasive species were. Governmental people knew what an invasive species was. There was a significant relation between where the respondents lived, and if they knew what an invasive species was. 64.2% of those from the central cites knew it, while only 22.5% from coastal cities knew about invasive species. In the recently established areas 46.6% said they knew what an invasive species were.

The questions were merged into the knowledge variable and run through an Anova test to test the means knowledge. Of all the variables only cities was significant (ANOVA, F = 4.84, df = 1, $p \leq 0.0285$; fig 2). This suggests that there is a difference in knowledge between the cities with house crow presence.The

results show that the mean knowledge score for the coastal cities was 0.947, for the medium was 1.295, and for inland cities it was 0.824. A Kruskal-Wallis test was conducted to determine if there were any significant differences in knowledge between the different cities. The test resulted in a Kruskal-Wallis score ($\chi^2 = 33.494$, df = 2, $p < 0.0005$). The small p-value give strong evidence that there is a significant difference between the knowledge between the cities. As a post hoc test a Dunn test was preformed to compare the different cites to each other. When comparing coastal cities with the medium cities a statistically significant difference in the median knowledge was found (Z = -3.618, p = 0.0009) the same happened when the medium cities were compared with the cities where house crows had been recently established (Z = 5.745 $p < 0.00002$). However, when comparing the cities with long and short history toward each other it was not significant (Z = 1.650 p = 0.297). This means that, on average, respondents from Dodoma and Morogoro scored higher on the knowledge test than participants from coastal cities or the most inland cities.

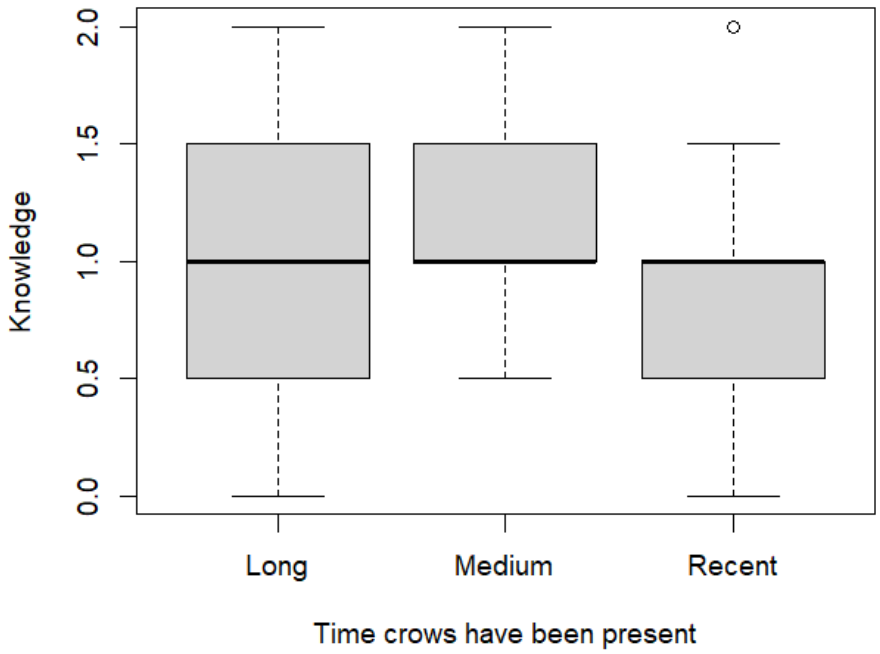

Figure 2: Knowledge based on the time house crows have been present

8.2 Attitudes

While living in close proximity with animals, people will develop some opinion towards birds in regard of how it effect their daily life. To the question "Does the presence of Indian house crow affect your daily life", most people (77.1%, n = 280) answered yes. But only location varied statistically significantly in regard to the response (Appendix 6). To determine if how people was affected, the following question would clarify if people were positive, neutral or negative effected by house crows. When asked "how it affect people", showed that 61.3 % were negatively affected by the presence of house crows. But that education, occupation and which city respondents lived in had a significant impact (Appendix 7). People with higher education were more likely to say they were negatively affected. Most people in Dodoma and

Morogoro (91.7%) said they were negatively affected by house crows. More than half of the respondents (63.6%, n =264) were economically affected by the presence of house crows, while 16.5% of the initial 316 respondents did not answer the questions (Appendix 8). People with lower education level were often more economical affected. People in the central cities were also more likely to be affected (73.6%) than the other areas.

The three previous questions were combined to create the attitude variable. Lower score was given to those with more positive attitudes towards house crows. Those with negative or neutral attitudes were given positive scores, with negative answers scoring higher than neutral. Ranging from -1 to 3 the mean score for the different levels of education was 0.194 for no education, 0.426 for primary school 0.656 secondary school and 0.815 for above secondary school. When running an Anova test, education had a statistically significant effect (F-value = 5.059, df = 3, p = 0.00196 fig 3). To test if there was a large difference between each of the levels of education a Kruskal-Wallis test was used (χ^2 = 15.427, df = 3, p = 0.00148). The Dunn test determined that there was only a significant difference between no education, and those with secondary school(Z = -2.853, p = 0.026) and those above secondary school(Z = 3.522, p = 0.002). Therefore, people with higher education was more negative towards house crows.

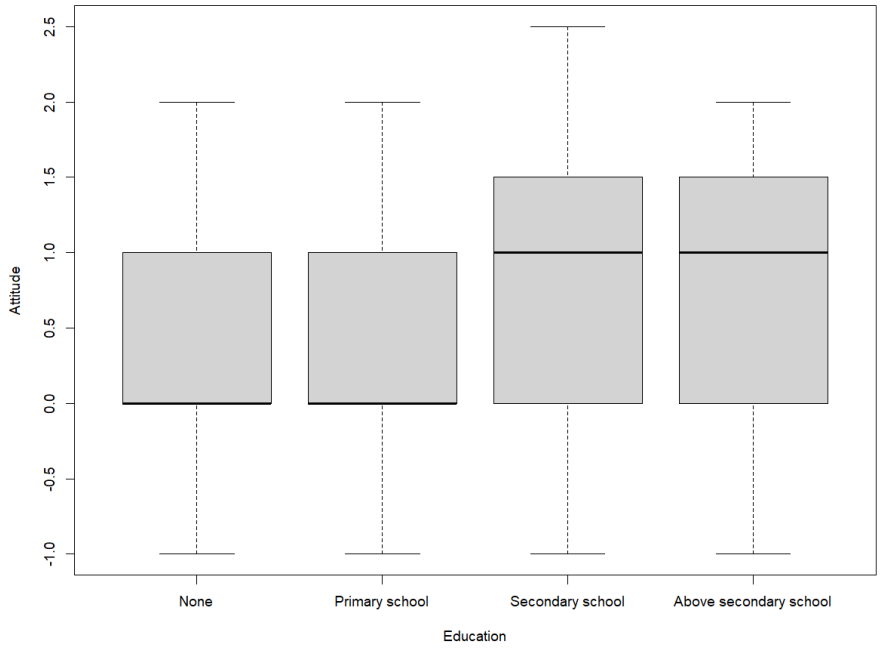

Figure 3: Attitude score based on education level

What city the respondents came from had a statistically significant effect on the attitude (F = 37.47, df = 2, $p \leq 0.00002$ fig 4) when running an Anova test. This suggests that there was a significant difference in attitudes across the different cities. The mean attitude value for the cities with long history was 0.982, for the cities with medium history was 1.795, and for the most recent 0.993. A Kruskal-Wallis test was used, it indicated that there was a significant difference between the attitude between the cities (χ^2 = 61.263, df = 2, $p \leq 0.0005$). When comparing the different cities toward each other, the long and medium cities were significantly different with the medium cities having more negative attitudes towards house crows (Z = -6.21983 $p \leq 0.0001$). When comparing the medium cities with the recent cities the medium cities had significantly more negative attitudes towards house crows than the cities were house crows

were recently established(Z = 7.316, $p \leq 0.00001$). When comparing the longest with the most recent cities it was no significant differences in attitudes(Z = 0.359, p = 1.00). Respondents from Dodoma and Morogoro were more negative towards hose crows.

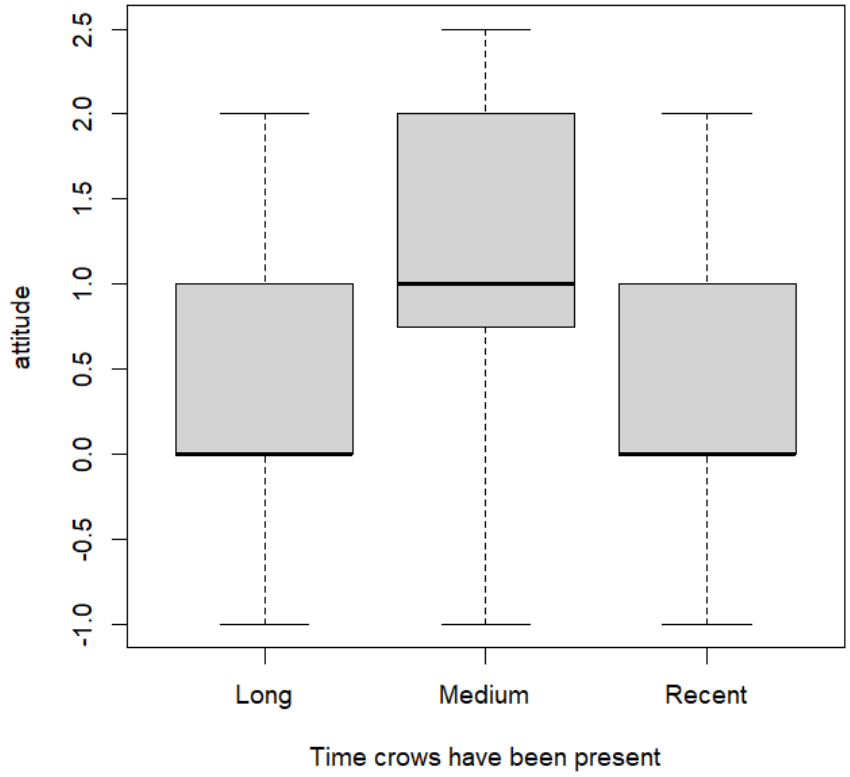

Figure 4: Attitude score in relation to how long they have been present in the cities.

8.3 Knowledge based attitude

The two last questions tried to identity the Tanzanian people's beliefs on how the house crows affect other birds and what total effect it would have to get rid of it. They were grouped into this category because these questions needed some level of understanding of invasiveness and how it may affect the environment. Here almost all variables varied significantly from one another, the only variable that was not significant was gender, when asked which effect house crows had on other birds (Appendix 9). Out of 261 respondents, 50.2% though that house crows had a negative effect on other birds. Surprisingly 21.1% of the respondents thought that house crows had a positive effect on other birds. Most people from the central cities thought house crows had an negative effect (62.0%). People above 46 years saw the negative effect of house crows (65.8%) more than younger people. People with higher education held the perception that the house crows would have a negative impact on the diversity of local bird species. Most of the respondents were positive to get rid of the house crows, and that they did more harm than good. 61.2% (n=258) believed it had a positive effect to get rid of them. Men were more positive towards exterminating the crows than women. Still most women through it would have a positive effect to get rid of the crows. Surprisingly, people who went trough primary school or had no education (61.8% and 66.3%), were more positive towards exterminating hose crows (Appendix 10). 75.0% of farmers were

also positive to get rid of house crows. Most respondents from the central cities (79.8%) were in favor for exterminating house crows compared to the remaining cities. Only 31.3% of people from the inland cities thought it would be positive to exterminate the crows.

Both education (F = 3.833 , df = 3, p = 0.0102) and city (F = 34.86, df = 2, p = 0.00001) were statistically significant when tested with an Anova test. The Kruskal-Wallis test indicates that there was a significant difference between the attitude in the different cities ((χ^2 = 63.055, df = 2, p- = 0.0001). The mean score for knowledge based attitude in the medium cities (2.48) was almost twice as high as the two others(long = 1.27, recent = 1.30). Showing that the average person in Morogoro and Dodoma were more aware of the consequences of house crows. The Dunn post-hoc test showed that there was a significant difference between the cities with long history with house crow presence and those with medium length (Z = -6.564, p = 0.0001). It was also a significant difference between the recent and medium length of presences (Z = 7.257, p = 0.0001). There was no significant difference between the coastal and recent cities (Z = -0.070, p = 1.00). People from the medium cities were more perceptive and understood that house crows could be dangerous to the environment and therefore would be positive to exterminate them.

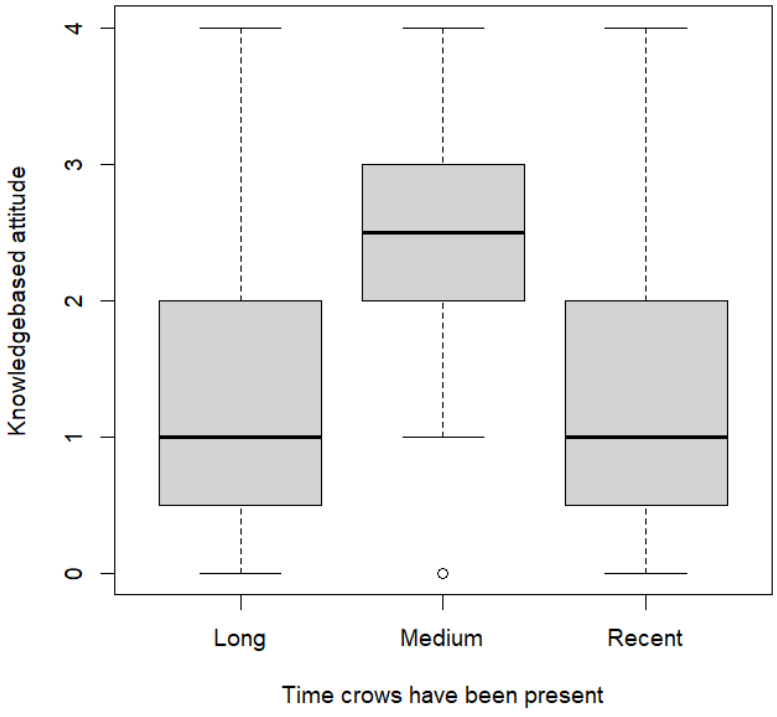

Figure 5: Knowledgebased attitude on the time house crows has been present

Since education was a significant factor that determined people's ability to see the consequences of the house crow. The mean score for knowledge-based attitudes went gradually up along with education level. With no education the score was 1.28, for primary school = 1.55, secondary school = 1.72, above secondary school = 2.04. The Kruskal-Wallis test indicated that there was a significant difference between the different education levels (χ^2 = 15.417, df = 3, p = 0.0015), but only between people with higher than secondary school and no education (Z = 3.656, p = 0.00154) and between people with higher education

than secondary school and primary school (Z = 2.807, p = 0.0299). The was no significant difference between the other levels of education. So people with higher education were more negative towards house crows.

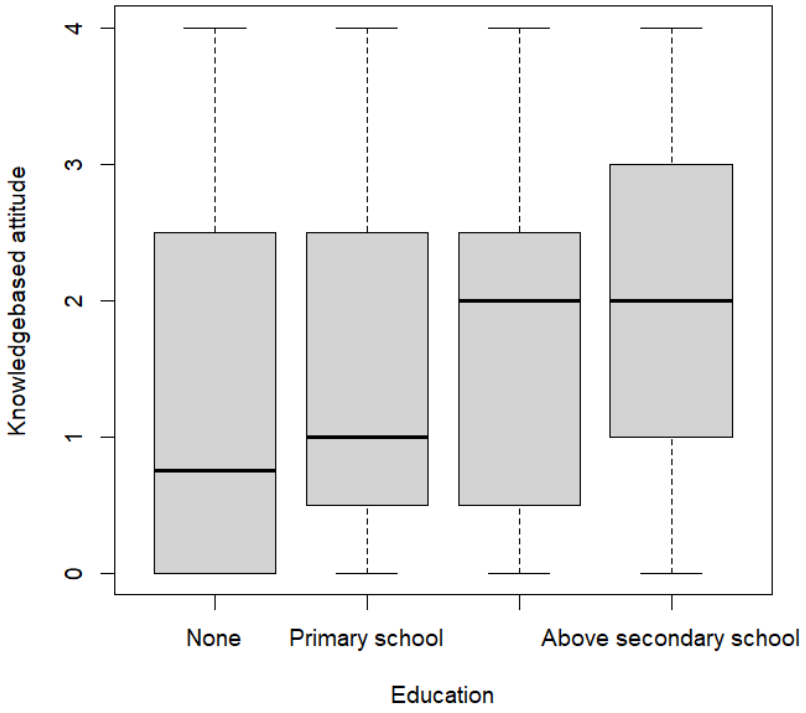

Figure 6: Knowledgebased attitude in relation to education

8.4 Models

To find the cause of respondent's knowledge of house crows 16 models were compared. The most fitting model for the knowledge variable was explained by location and occupation (Akaike weight = 0.69, Table 2). This was the only model with a delta lower than 2.00. Location and occupation seem like predictors that explain the knowledge factor, but the effect of the variables is independent of each other.

To asses the attitude of house crows 20 different models were compared to each other (Table 3). Location and knowledge were the two most influential factors on attitude. City and knowledge were tested both as an two independent variables and with interaction of each other. The model without interaction fit the best. The most fit model was weighted much heavier than the others (Akaike weight = 0.98, Table 3).

For the knowledge-based attitudes 35 models were tested. The model that had the best fit had the predictor variables education and knowledge and interaction between city and attitude (Akaike weight = 0.97, (Table 4).

Table 2: Model selection for knowledge of House crows

Model	df	logLik	AICc	delta	Weight
Knowledge					
CITY + JOB	8	-266.81	550.09	0.00	0.69
CITY	4	-272.83	553.78	3.69	0.11
CITY * EDU	13	-263.88	554.98	4.89	0.06
CITY + GEN	5	-272.54	555.28	5.19	0.05
CITY + EDU	7	-270.50	555.36	5.26	0.05
CITY * JOB	16	-261.51	556.84	6.74	0.02
CITY * AGE	13	-265.55	558.31	8.22	0.01
EDU * GEN	7	-272.17	558.69	8.60	0.01
EDU * AGE	8	-279.56	575.60	25.50	0.00
AGE	5	-282.91	576.01	25.92	0.00
JOB	6	-282.27	576.80	26.71	0.00
EDU	5	-288.04	586.27	36.18	0.00
EDU + GEN	6	-287.11	586.50	36.40	0.00
GEN	3	-290.39	586.85	36.76	0.00
EDU * AGE	17	-275.97	588.01	37.92	0.00
EDU * GEN	9	-285.22	589.03	38.94	0.00

Notes: CITY, the merged cities. EDU, education level. AGE, age of respondent. JOB, occupation of the respondent. SEX, gender of the respondent.

Table 3: Model selection for attitude of House crows

Model	**df**	**logLik**	**AICc**	**delta**	**Weight**
Attitude					
CITY+KNOW	7	-393.06	800.48	0.00	0.98
CITY+EDU	7	-397.78	809.93	9.46	0.01
CITY+AGE	5	-400.20	810.59	10.11	0.01
CITY*EDU	13	-391.72	810.65	10.17	0.01
CITY*AGE	7	-399.25	812.86	12.38	0.00
CITY	4	-402.93	814.00	13.52	0.00
CITY*KNOW	5	-402.03	814.26	13.78	0.00
CITY+GEN	5	-402.50	815.19	14.71	0.00
CITY*GEN	7	-400.91	816.18	15.70	0.00
EDU+AGE	6	-423.98	860.24	59.76	0.00
EDU*AGE	9	-421.79	862.18	61.70	0.00
EDU*GEN	6	-425.86	863.99	63.51	0.00
EDU	5	-427.30	864.80	64.33	0.00
EDU+KNOW	6	-426.58	865.43	64.96	0.00
EDU+GEN	9	-424.85	868.28	67.81	0.00
EDU*KNOW	9	-426.16	870.90	70.43	0.00
JOB	3	-433.58	873.25	72.77	0.00
AGE	3	-433.61	873.30	72.83	0.00
GEN	3	-435.62	877.33	76.85	0.00
KNOW	3	-435.87	877.82	77.34	0.00

Notes: CITY, the merged cities. EDU, education level. AGE, age of respondent. JOB, occupation of the respondent. SEX, gender of the respondent. KNOW, knowledge of house crows.

Table 4: Model selection for knowledge-based attitude of House crows

Model	df	logLik	AICc	delta	Weight
Knowledge-based attitude					
CITY*ATT+EDU+KNOW	11	-431.91	886.70	0.00	0.97
CITY+EDU+ATT*KNOW	10	-437.46	895.64	8.94	0.01
CITY+EDU+ATT+KNOW	9	-438.80	896.19	9.49	0.01
CITY+EDU*ATT+KNOW	12	-436.00	897.04	10.34	0.01
CITY+EDU*KNOW+ATT	12	-436.76	898.55	11.85	0.00
CITY+AGE+ATT+KNOW	9	-440.16	898.91	12.21	0.00
CITY+ATT+KNOW	6	-443.71	899.68	12.98	0.00
CITY*KNOW+EDU+ATT	11	-438.79	900.46	13.76	0.00
EDU+ATT+KNOW	7	-443.09	900.54	13.83	0.00
CITY+GEN+ATT+KNOW	7	-443.27	900.90	14.19	0.00
ATT+KNOW	4	-448.25	904.62	17.92	0.00
ATT*KNOW	5	-447.33	904.85	18.15	0.00
CITY*EDU+KNOW	14	-453.29	935.99	49.29	0.00
CITY+EDU+KNOW	8	-464.21	944.89	58.19	0.00
CITY+EDU*KNOW	10	-462.50	945.73	59.03	0.00
CITY+KNOW	5	-471.07	952.34	65.63	0.00
CITY*EDU*KNOW	25	-449.52	953.55	66.84	0.00
CITY*KNOW	7	-469.62	953.60	66.90	0.00
CITY*ATT	7	-473.53	961.43	74.73	0.00
CITY+ATT	5	-475.99	962.18	75.48	0.00
EDU*KNOW	6	-480.65	973.57	86.86	0.00
CITY*EDU	13	-475.42	978.05	91.35	0.00
EDU*ATT	9	-480.07	978.73	92.03	0.00
EDU+ATT	6	-484.30	980.87	94.17	0.00
EDU*ATT	9	-482.12	982.83	96.12	0.00
KNOW	3	-489.98	986.04	99.34	0.00
CITY+EDU	7	-489.49	993.34	106.64	0.00
CITY+AGE	7	-491.91	998.18	111.48	0.00
CITY	4	-495.37	998.87	112.17	0.00
CITY*GEN	7	-492.69	999.74	113.03	0.00
CITY*AGE	13	-486.80	1000.81	114.10	0.00
CITY+GEN	5	-495.36	1000.92	114.21	0.00
EDU+AGE	8	-511.17	1038.81	152.10	0.00
JOB	6	-516.70	1045.68	158.98	0.00
EDU	5	-518.04	1046.28	159.58	0.00
GEN+EDU	6	-517.79	1047.85	161.14	0.00
EDU*AGE	17	-506.06	1048.20	161.50	0.00
GEN*EDU	9	-517.32	1053.23	166.52	0.00
AGE	5	-521.88	1053.96	167.26	0.00
GEN	3	-526.95	1059.98	173.28	0.00

Notes: CITY, the merged cities. EDU, education level. AGE, age of respondent. JOB, occupation of the respondent. SEX, gender of the respondent. KNOW, knowledge of house crows. ATT, attitude towards house crows.

9 Discussion

Does the general public in Tanzania know what a house crow is, and how it affects its surroundings? The first questions try to establish if Tanzanians were able to distinguish the difference between the pied crow and the house crow. In Question 1, answers like white crow, white house crow etc. was interpreted that the participant was able to separate the pied crow from the house crow by appearance. Less than 25% were able to correctly identify pied crows. Even less were able to correctly name the pied crow by correct name meaning there is a lack of knowledge. Most of the people able to identify pied crow had higher education than secondary school. This could point to more biology teaching in schools after secondary school. According to Tidemann (2012) local people may gain knowledge about local birds in a more immersive way, by looking at sound, habit and so on. Being presented a picture some might find it harder to interpret and therefore misidentify it. Location seems to have a high effect on this knowledge. With almost none from Tanga and Dar es Salaam knowing what pied crows was, can be answered with the lack of presence of pied crows in these areas (Feare & Mungroo, 1990). Pied crows are less common around the coastal cities since house crows have been displacing them (Røskaft et al., 2023). With 81.2 % of people in the coastal cities giving wrong answer when seeing the picture of a pied crows, may be because they share similar visual characteristics. So, people used to see house crows more often just assume it is the same bird. In Arusha and Moshi were house crows is barley present, pied crows is more abundant and seen more regularly, since they prefer agricultural areas and savanna biomes over more dense cities (Londei, 2010). Still 55.9% thought it was another bird or didn't know, so If house crows continue to increase in numbers in these areas there is a risk for house crows to out-compete pied crows. The huge difference between the number of people being able to identify house crows and not pied crow can show that house crows were more on people's mind and was more frequently discussed. Since 47,2% of all respondents were not able to identify the pied crow, even though pied crows are the native species, may be because pied crows are less present in densely populated areas (Ryall, 1992). Since all questionnaires were performed in the city-center, this might miss represent knowledge of Tanzanians and only be representative of people living in the city. Originally from densely populated areas in Asia, house crows are more adapted to living in close proximity to humans and don't need as much open grasslands, and fields as pied crows do (Londei, 2010). Because of the previous eradication program, the general public might have become more aware of house crows, and therefore 56.0% of the respondents were able to identifying house crows. Looking at respondents' ability to identify house crows reveals that there was no noticeable improvement as the level of education increased. On the other hand, wrong answers became less frequent with increased education. So, people were less likely too randomly guess. Surprisingly people from the coastal cities were worse at identifying house crows than respondents in the medium cities. it was predicted that people it the cities with a longer recorded finding of crows would be better at identify them. To the question "Do you know what an invasive species is", revealed that people in central cities to a high degree knew what an invasive species was. The knowledge of invasive species might be because of the change of abundance of house crows. During the last centuries the house crow population has rapidly increased (Ndimuligo et al., 2022). And people in Morogoro and Dodoma have seen the biggest change in their daily environment. In Tanga and Dar Es Salaam the house crow has been present for over 120 years, almost twice the expected lifespan of humans in Tanzania (The World Bank, 2021). Since nobody has seen the arrival of the crows, they are currently more a part of their daily life. Possibly making people on the coast to be more tolerant towards the house crows and recognizes them as a native bird. This is supported by the fact that 67.5 % of respondents in the coastal cities didn't know if the house crows belonged in Tanzania or not, and that 12% believed that the crows

belonged in Tanzania. From the Anova test education level had no significant effect on the knowledge variable. Contrary to what was predicted, it was expected that knowledge about house crows would increase with the higher level of education. This may be due to less focus on biology in lower levels of school in Tanzania. The level of knowledge about birds may then derive from other sociological factors than school. Where people live seem to be the biggest factor for the knowledge people have about house crows. As the human population is growing and cities expands, house crows can displace pied crows. As people are already more aware of the house crow this might threaten the livelihood of pied crows (Ndimuligo et al., 2022; Ryall, 1992). Furthermore, as humans expand and take over, bringing house crows to newer areas and expanding their range, they are forcing pied crows into smaller pockets of habitats.

In urban areas it is encouraged to decrease the numbers of negative interactions between humans and wildlife. Whether an animal is seen as an problem usually depends on humans perception and values (O'Donnell & VanDruff, 1983). Overall Tanzanians have negative associations to house crows. 61,3 % of the felt like house crows affected them negatively. People who had a higher levels of education had more negative attitudes towards house crows. Respondents answers became more and more positive as their level of education dropped. with 58.8% of people without education saying house crows contributed positively into their daily life. While 72.7% people with the highest levels of education said they were negatively affected in their daily life. Respondents with lower levels of education were also more frequently affected economically than people with higher education. When combining all the questions on attitude. Education was still an important factor for people's perceptions about house crows, but it was just a significant difference between those with secondary school or above compared with people without any education. People's perception could be more understood by investigation which city respondents were from. The amount of people affected by house crows in their daily life was strongly affected by witch area people lived in. Unlike what was predicted, more respondents from the the medium cities felt they were affected by house crows in their daily life. In Dar es Salaam and Tanga people answered more frequently that they were not affected by crows even though the number of crows is considerably larger in these cities (Shimba & Jonah, 2017). The number of people that felt crows affected their life was considerably larger than the number of people with the ability to recognize the species. Because of the long history with house crows in the coastal cities, Tanga and Dar es Salaam, no humans living today has seen the cites without the crows. The crows have become a part of the cities (Ntapanta, 2023). Since no one can recall a time without them. People have become used to crows and will pay less attention to them. With a higher number of house crows, the assumption that more people would have a more negative perception was miss aligned. Since most people (48.1%) in coastal areas felt house crows contributed positive to their daily life. The invasive behavior might is less influential her. Because Dar es Salaam is the biggest city in Tanzania people might be less connected to nature an the small daily interactions with crows brings more positive emotions (Mayer, Frantz, Bruehlman-Senecal, & Dolliver, 2009). On the other side, the most inland cities where the crows are rarely observed, ignorance towards the bird might be the reason for less negative attitudes. Since Morogoro and Dodoma have during the last decades seen the arrival and establishment of the crow, people here are less tolerant. The collective memory of the time without them is still present among these inhabitants. Her 91.7% of people say they are negatively affected by house crows. This is significantly higher than the amount of people feeling negatively affected in the other cities.

When it came to the question regarding the consequences of invasive species on other birds, education became a more important factor. Respondents with a higher level of education was better at assessing the

threat house crows can be to native birds. Since this requires people to think about biological interaction require more critical thinking, than just in identifying the birds. The thought process that nonnative species can have negative consequences may therefore stem from school. Even though people couldn't identify house crows before the questionnaire, respondents with higher level of education were able to see that the house crow might cause negative effects. It will therefore be beneficial to go longer to school. Even though the average person in a population might not be able to identify birds by name, a higher level of education will lead to more skepticism towards invasive species. By digging into the peoples knowledge, we wanted to see what effect crows has on the environment and what effect it would have to get grid of them. Overall people thought that house crows had neutral or negative effect on other birds. People from Dodoma and Morogoro believed house crows had negative effects on birds, and only 3.3% of the respondents said crows had a positive effect. The same people believed exterminating house crows would have a positive effect all together with only 4.3% thinking it was a bad thing to exterminate house crows.

Respondents can with higher accuracy recognize the effects crows have on both people and the environment from an opinion based on changes over time. To prove this, we should encourage researchers to do a survey again in the inland cities, if the house crows were to establish themselves over time. Even though 27,2% of people said that house crows belonged to Tanzanian nature more than twice (60%) said it would have a positive effect to exterminate the crows. This could indicate that people don't care so much about the crows origin, but see the crows as an annoyance by their unafraid behavior, like stealing food, and dive-bombing people (Shimba & Jonah, 2017). It is not the fact that house crows are invasive which drive the negative attitude towards the crows. Even though the highest level of education seems to have a great impact on what people know and feel about the presence of house crows, it seems like which city you live in has a much higher effect. Dar es Salaam and Tanga might have reached a threshold where the house crows have become a part of the cities, therefore crows are overlooked more frequently than in both the medium cities and newer cities. This could mean that the change in numbers is what affects people's attitude towards them. With more changes in the daily life of people it is more apparent that it might cause problems having crows in Tanzania. Because the consequences will be larger as the population grows.

The decision to use a Tanzanian assistant, knowing the Swahili language, to implement the questioner was to reduce the bias towards foreigners. And to avoid answers to please the interrogator. When answering questions regarding if you are affected or not, one becomes much more conscious about one opinion on the matter. Even though people are not affected in their daily life, occasionally interactions might be ambiguous. Several of the respondents skipped one or more of the questions which might leave out important information because of logical errors in the flow of questions. Because of missing data the researchers were forced to skip the full questioners. Lack of data would leave later questions open for interpretation. To avoid this the full entry was skipped. To get a further understanding on people's perception an knowledge in Tanzania further questioning should be done. With so many people not knowing much about the house crows give an indication that information about invasive species should be more focused on in Tanzania.

10 Conclusion and further work

This study of Tanzanians knowledge an attitude towards house crows was independent of all socioeconomic variables except education. Attitudes and knowledge were mostly influence by the geographical area where people lived. Even though higher education seems to have a great impact on what people feel about the presence of house crows, it seems like which city respondents lived in has a much higher effect. People in Dodoma and Morogoro have witnessed the establishment and rapid growth of house crows the last decades. The increase in population of house crows seem to influence people in a higher degree, unlike where crows are barely present or the areas where population has become more saturated.People in Dodoma and Morogoro with the highest levels of education had most knowledge and the most negative attitudes towards house crows. With the negative impacts house crows bring like; negatively effecting biodiversity, destruction of crops spread of diseases, and annoyance towards humans, management should be implemented. As house crows continue to spread inland information about the effects they bring on local biodiversity and human may be a preventative method to avoid further distribution. An education program to spread more information about house crows would be beneficial to spread awareness. Proper litter disposal and food availability could reduce the house crows ability to establish in new areas. As it is easier to prevent immigration than to get rid of an already established species. With a direct change in your environment people have developed more awareness of the challenges house crows bring to the Tanzanian country.

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11 Appendix 1

House Crow

Gender
- ○ Man
- ○ Woman

Age
.....

Tribe
.....

Education
- ○ none
- ○ Primary school
- ○ Secondary school
- ○ Above secondary school

Occupation
- ○ None
- ○ Farming
- ○ Governmental
- ○ Private
- ○ Other

Witch city do you live in?
- ○ Arusha
- ○ Moshi
- ○ Tanga
- ○ Dar es Salaam
- ○ Morogoro
- ○ Dodoma
- ○ Singida
- ○ (Other)...

What bird is this?

.....

What bird is this?

.....

Is this Indian house crow a bird that belongs to the Tanzanian nature?

- ○ Yes
- ○ No
- ○ I don't know

if no, why?

.....

Do you know what an invasive species is?

- ○ Yes
- ○ No

Where do you see most house crows?

- ○ Never see them
- ○ In the town center
- ○ Outside the town center
- ○ Other

How do you perceive the number of house crow in your area?

- ○ Too High
- ○ High
- ○ Medium
- ○ Low
- ○ Too Low

Have you seen their nest?

- ○ Yes
- ○ No
- ○ I don't know

Does the presence of Indian house crow affect you daily life?

- ○ Yes
- ○ No

If yes, how does the Indian house crow affect your daily life

- ○ Positive
- ○ Neutral
- ○ Negative

How?

.....

The presence of Indian house crow has an economic effect on your life?

- ○ Strongly Agree
- ○ Agree
- ○ Neutral
- ○ Disagree
- ○ Strongly Disagree

What kind of effect do you think house crows has on other birds?

- ○ Very Positive
- ○ Positive
- ○ Neutral
- ○ Negative
- ○ Very Negative

What kind of effect will it have to get rid of the Indian house crow?

- ○ Very Positive
- ○ Positive
- ○ Neutral
- ○ Negative
- ○ Very Negative

What institution should be responsible to get rid of the Indian house crow?

- ○ City Council
- ○ Government
- ○ Wildlife Department
- ○ Schools
- ○ Other

How could you help get rid of this species

.....

Are you willing to participate in crow eradication programme without payments?

- ○ Yes
- ○ No

How do you want the government to deal with the house crow?

.....

What could they(government) do different?

.....

Thank You

12 Appendix 2

Table 5: The different variables that differed significantly from each other in the response to the question "What bird is this?". When shown a picture of pied crows.

Variables	Description	Identify pied crow (%)			χ^2	df	$p \leq$
		Correct	Partial	Wrong			
Gender	Man	20.9%	36.8%	42.3%	6.012	2	0.049
	Woman	23.5%	24.2%	52.3%			
Age	16-25	21.7%	55.0%	23.3%	28.286	6	0.001
	26-35	21.7%	22.5%	55.8%			
	36-45	27.1%	22.4%	50.6%			
	46+	14.3%	36.7%	47.1%			
Education	None	9.3%	11.1%	79.6%	71.418	6	0.001
	Primary school	16.7%	24.1%	59.3%			
	Secondary school	21.1%	37.8%	41.1%			
	Above secondary school	45.2%	46.8%	8.1%			
Occupation	None	16.1%	29.0%	54.8%	94.121	8	0.001
	Farming	37.0%	18.5%	44.4%			
	Governmental	56.5%	26.1%	17.4%			
	Private	18.0%	12.0%	70.0%			
	Other	11.8%	65.8%	22.4%			
City	Recent	41.2%	2.9%	55.9%	226.279	4	0.001
	Medium	12.6%	83.2%	4.2%			
	Long	2.4%	16.5%	81.2%			

13 Appendix 3

Table 6: The different variables that differed significantly from each other in the response to the question "What bird is this?" When shown a picture of a house crow.

Variables	Description	Identify house crow (%)			χ^2	df	$p \leq$
		Correct	Partial	Wrong			
Gender	Man	58.3%	25.2%	16.6%	1.354	2	0.508
	Woman	53.6%	24-8%	21.6%			
Age	16-25	61.7%	31.7%	6.7%	13.372	6	0.037
	26-35	49.2%	24.2%	26.7%			
	36-45	55.3%	27.1%	17.6%			
	46+	65.3%	16.3%	18.4%			
Education	None	53.7%	11.1%	35.2%	43.381	6	0.001
	Primary school	59.3%	17.6%	23.1%			
	Secondary school	64.4%	22.2%	13.3%			
	Above secondary school	41.9%	51.6%	19.1%			
Occupation	None	53.2%	12.9%	33.9%	39.695	8	0.001
	Farming	46.3%	37.0%	16.7%			
	Governmental	39.1%	56.5%	4.3%			
	Private	54.0%	23.0%	23.0%			
	Other	73.7%	18.4%	7.9%			
City	Recent	34.6%	41.2%	24.3%	62.143	4	0.001
	Medium	84.2%	9.5%	6.3%			
	Long	58.8%	16.5%	24.7%			

14 Appendix 4

Table 7: The different variables that differed significantly from each other in the response to the question "Is this Indian house crow a bird that belongs to the Tanzanian nature?

Variables	Description	Belong in Tanzania (%)			χ^2	df	$p \leq$
		Yes	I don't know	No			
Gender	Man	29.0%	50.6%	20.4%	0.802	2	0.670
	Woman	26.5%	55.6%	17.9%			
Age	16-25	44.1%	40.7%	15.3%	11.592	6	0.072
	26-35	21.8%	55.5%	22.7%			
	36-45	25.0%	56.0%	19.0%			
	46+	26.5%	59.2%	14.3%			
Education	None	13.2%	73.6%	13.2%	39.802	6	0.01
	Primary school	16.8%	66.4%	16.8%			
	Secondary school	38.9%	41.1%	20.0%			
	Above secondary school	44.3%	27.9%	27.9%			
Occupation	None	27.9%	60.7%	11.5%	10.316	8	0.244
	Farming	35.2%	44.0%	20.4%			
	Governmental	39.1%	39.1%	21.7%			
	Private	24.2%	50.5%	25.3%			
	Other	24.0%	60.0%	16.0%			
City	Recent	31.1%	52.6%	16.3%	17.657	4	0.001
	Medium	36.8%	41.1%	22.1%			
	Long	12.0%	67.5%	20.5%			

15 Appendix 5

Table 8: The different variables that differed significantly from each other in the response to the question" Do you know what an invasive species is?"

Variables	Description	Invasive species (%)		χ^2	df	$p \leq$
		Know	Don't know			
Gender	Man	49.0%	51.0%	0.828	1	0.363
	Woman	43.8%	56.3%			
Age	16-25	58.9%	41.1%	6.260	3	0.1
	26-35	39.3%	60.7%			
	36-45	49.40%	50.6%			
	46+	43.5%	56.5%			
Education	None	24.0%	76.0%	47.523	3	0.001
	Primary school	30.6%	69.4%			
	Secondary school	55.7%	44.3%			
	Above secondary school	78.3%	21.7%			
Occupation	None	47.3%	52.7%	20.901	4	0.01
	Farming	58.5%	41.5%			
	Governmental	82.6%	17.4%			
	Private	35.9%	64.1%			
	Other	39.2%	60.8%			
City	Recent	46.6%	53.4%	28.372	2	0.001
	Medium	64.2%	35.8%			
	Long	22.5%	77.5%			

16 Appendix 6

Table 9: The different variables that differed significantly from each other in the response to the question" Does the presence of Indian house crow affect you daily life?"

Variables	Description	Effect daily life (%)		χ^2	df	$p \leq$
		Yes	No			
Gender	Man	25.5%	74.5%	1.207	1	0.272
	Woman	80.0%	20.0%			
Age	16-25	83.1%	16.9%	3.551	3	0.314
	26-35	71.3%	28.7%			
	36-45	80.3%	19.7%			
	46+	76.2%	23.8%			
Education	None	66.7%	33.3%	5.203	3	0.158
	Primary school	75.5%	34.5%			
	Secondary school	77.8%	22.2%			
	Above secondary school	85.5%	14.5%			
Occupation	None	78.0%	22.0%	4.291	4	0.368
	Farming	77.1%	22.9%			
	Governmental	91.3%	8.7%			
	Private	71.4%	28.6%			
	Other	78.7%	21.3%			
City	Recent	73.3%	26.7%	8.929	2	0.012
	Medium	87.4%	12.6%			
	Long	69.2%	30.8%			

17 Appendix 7

Table 10: The different variables that differed significantly from each other in the response to the question"If yes, how does the Indian house crow affect your daily life?"

Variables	Description	Effect on life (%)			χ^2	df	$p \leq$
		Positive	Neutral	Negative			
Gender	Man	24.4%	7.9%	67.7%	4.594	2	0.101
	Woman	54.3%	11.2%	34.5%			
Age	16-25	25.0%	11.5%	63.5%	5.079	6	0.534
	26-35	26.4%	11.5%	62.1%			
	36-45	36.4%	7.6%	56.1%			
	46+	27.8%	2.8%	69.4%			
Education	None	58.8%	2.9%	38.2%	23.121	6	0.001
	Primary school	30.8%	10.3%	59.0%			
	Secondary school	26.7%	8.0%	65.3%			
	Above secondary school	12.7%	14.5%	72.7%			
Occupation	None	31.8%	9.1%	59.1%	16.076	8	0.041
	Farming	27.3%	15.9%	56.8%			
	Governmental	19.0%	14.3%	66.7%			
	Private	40.5%	9.5%	50.0%			
	Other	18.3%	3.3%	78.3%			
City	Recent	37.1%	14.3%	48.6%	52.072	4	0.001
	Medium	7.1%	1.2%	91.7%			
	Long	48.1%	13.0%	38.9%			

18 Appendix 8

Table 11: The different variables that differed significantly from each other in the response to the question "The presence of Indian house crow has an economic effect on your life?"

Variables	Description	Economic affect (%)			χ^2	df	$p \leq$
		Agree	Neutral	Disagree			
Gender	Man	61.3%	21.9%	16.8%	2.115	2	0.347
	Woman	66.1%	15.0%	18.9%			
Age	16-25	61.4%	28.1%	10.5%	11.066	6	0.086
	26-35	58.5%	21.3%	20.2%			
	36-45	67.6%	9.9%	22.5%			
	46+	72.5%	12.5%	15.0%			
Education	None	81.1%	8.1%	10.8%	24.634	6	0.01
	Primary school	65.9%	12.9%	21.2%			
	Secondary school	67.1%	14.6%	18.3%			
	Above secondary school	44.1%	39.0%	16.9%			
Occupation	None	63.3%	20.4%	16.3%	4.386	8	0.821
	Farming	63.6%	13.6%	22.7%			
	Governmental	50.0%	22.7%	27.3%			
	Private	63.7%	18.8%	17.5%			
	Other	68.1%	18.8%	13.0%			
City	Recent	54.7%	20.8%	24.5%	9.151	4	0.057
	Medium	73.6%	16.5%	9.9%			
	Long	64.2%	17.9%	17.9%			

19 Appendix 9

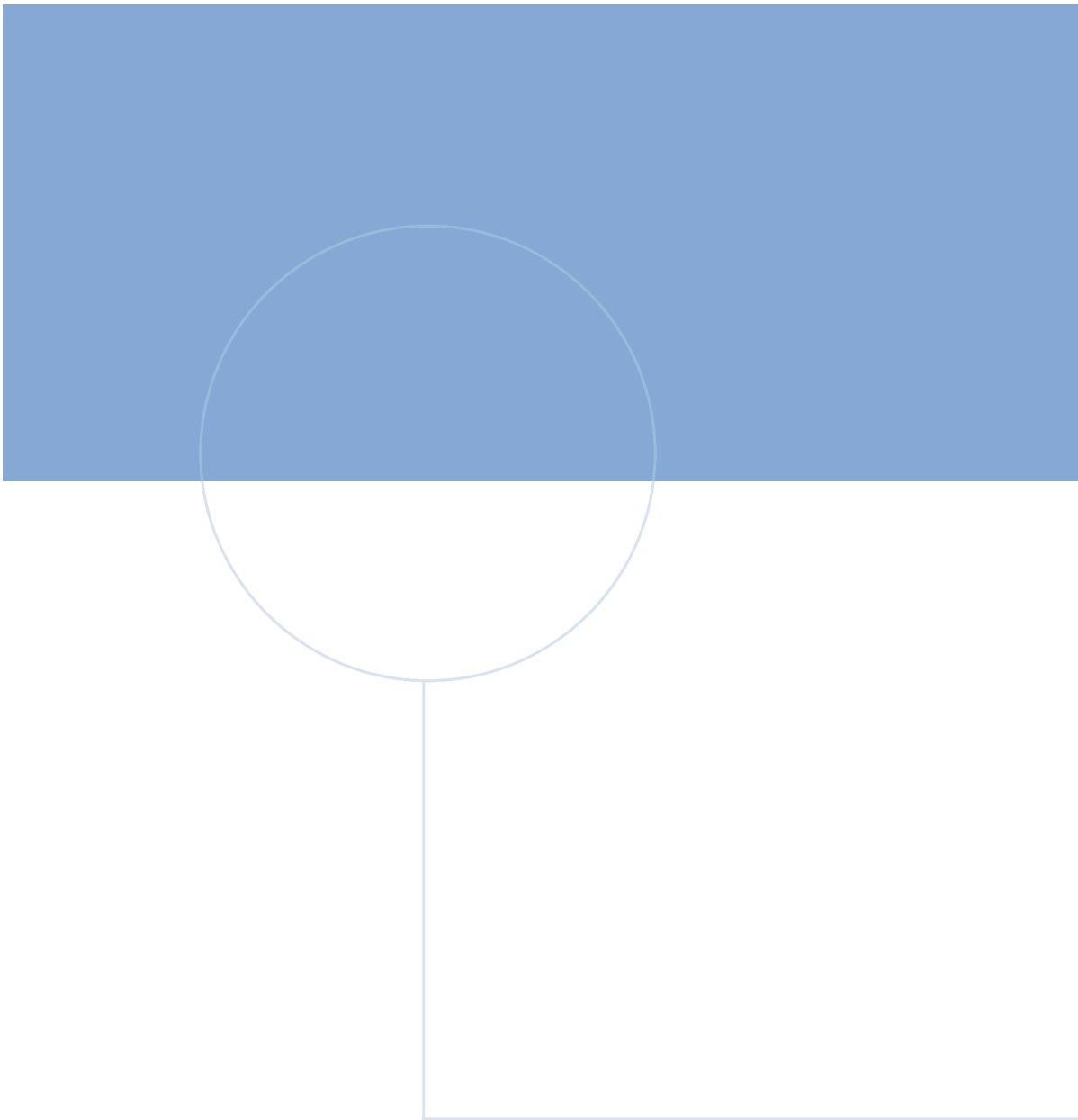
Table 12: The different variables that differed significantly from each other in the response to the question "What kind of effect do you think house crows has on other birds?

Variables	Description	Effect of other birds (%)			χ^2	df	$p \leq$
		Positive	Neutral	Negative			
Gender	Man	20.9%	24.6%	54.5%	2.630	2	0.268
	Woman	21.3%	33.1%	45.7%			
Age	16-25	17.2%	41.4%	41.4%	13.562	6	0.035
	26-35	18.5%	31.5%	50.0%			
	36-45	26.8%	22.5%	50.7%			
	46+	23.7%	10.5%	65.8%			
Education	None	30.6%	33.3%	36.1%	19.507	6	0.03
	Primary school	27.4%	15.5%	57.1%			
	Secondary school	20.7%	32.9%	46.3%			
	Above secondary school	21.2%	28.8%	50.0%			
Occupation	None	12.2%	46.9%	40.8%	26.234	8	0.001
	Farming	27.9%	14.0%	58.1%			
	Governmental	9.5%	23.8%	66.7%			
	Private	33.8%	24.7%	41.6%			
	Other	12.7%	31.0%	56.3%			
City	Recent	33.7%	16.3%	50.0%	38.053	4	0.001
	Medium	3.3%	34.8%	62.0%			
	Long	26.2%	40.0%	33.8%			

20 Appendix 10

Table 13: The different variables that differed significantly from each other in the response to the question "What kind of effect will it have to get rid of the Indian house crow?"

Variables	Description	Effect of extermination (%)			χ^2	df	$p \leq$
		Positive	Neutral	Negative			
Gender	Man	69.4%	17.9%	12.7%	7.832	2	0.02
	Woman	52.4%	28.2%	19.4%			
Age	16-25	67.9%	21.4%	10.7%	13.956	6	0.03
	26-35	47.8%	31.1%	21.1%			
	36-45	64.8%	16.9%	18.3%			
	46+	76.9%	15.4%	7.7%			
Education	None	61.8%	11.8%	26.5%	18.788	6	0.005
	Primary school	66.3&	12.8%	20.9%			
	Secondary school	7.7%	33.3%	59.0%			
	Above secondary school	12.6%	30.5%	55.9%			
Occupation	None	52.1%	20.8%	27.1%	18.370	8	0.019
	Farming	75.0%	18.2%	6.8%			
	Governmental	59.1%	36.4%	4.5%			
	Private	50.7%	27.4%	21.9%			
	Other	70.4%	18.3%	11.3%			
City	Recent	31.3%	31.3%	37.5%		4	0.001
	Medium	79.8%	16.0%	4.3%			
	Long	63.0%	24.0%	15.9%			



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