

Improving Romania's Bear Reporting and Data Collection Methods

Arthur Ames
Chris Danti
Tevin Makoye
Ravyn Rapley
Jakob Simmons



WPI



**Code for
Romania**

Improving Romania's Bear Reporting and Data Collection Methods

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By:
Arthur Ames
Chris Danti
Tevin Makoye
Ravyn Rapley
Jakob Simmons

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Professors Melissa Butler and Melissa Belz
Worcester Polytechnic Institute

Abstract

Although Romania is one of the most biodiverse countries in Europe, both land use changes and poor management of protected lands has rapidly depleted Romania's natural resources and led to an increase in human-animal interactions with the current reporting system being inefficient and antiquated. Through interviews with environmental experts and government officials we determined that habitat loss is causing more bears to encounter humans threatening safety in Romania. To address this issue, our team developed a prototype for a digital reporting tool for bear sightings that will be implemented in a national universal reporting tool our collaborator is developing: Public Reporter.

EXECUTIVE SUMMARY

Romania has rich biodiversity due to its varied geography and climate. Located in southeastern Europe, it is famous for its natural wonders, landscapes, and forested regions. More than 30% of Romania is covered by forests (Worldbank, 2020), including the largest area of virgin and old-growth forests in Europe (Bondici, 2022). The vast forests allow for habitats for many different species, such as the brown bear; Romania is currently home to 60% of Europe's brown bear population (Ozkurt, n.d.). Romania's Danube Delta is home to 45 freshwater fish species and over 300 other aquatic species. Romania also has over 3700 identified plant species (Pupuza, 2019), making it home to diverse ecosystems rich in flora and fauna.

Although Romania is home to flourishing ecosystems, they are in danger of rapid habitat loss. In the late 1940's, Romania became a communist nation that "emphasized heavy industry" (Mazurski, 1991) such as mining requiring vast amounts of land area, which led to deforestation (Okia, 2012). After transitioning to a capitalist society in 1989, Romania's actions towards the environment changed, but outcomes remained the same.

Capitalism encouraged the destruction of the environment through an-

thropogenic activities to make a profit. Illegal logging in Romania is a pressing issue facing forests; an investigation by WWF Romania showed that over 40% of the wood shipments from Brasov and Sibiu counties are illegal (Dumitrescu, 2022). Because loggers are harvesting more trees than legally allowed, the forests are being destroyed at a faster rate than intended. This is destroying the habitat for animal species who require the forests to survive.

Figure A: *Nature in Făgăraș Mountains: the virgin forests of Romania.*



The Danube Delta is also an example of biodiversity suffering due to habitat loss. The emergence of tourism in the Danube is decimating local fish populations. Sfântu Gheorghe village is a popular tourist destination in the Danube that welcomes around 10,000 tourists who come to visit the delta every year (Ivan, 2016). The locals of SG village feed tourists the local fish species as a delicacy, causing a

sharp decrease in fish populations due to overconsumption.

Capitalism also brought a new perspective on environmental protection. Romania created the Ministry of Environment to “protect the environment and natural resources to guarantee current and future generations a clean environment, in harmony with economic development and social progress”.

Objectives and Goal

We worked with Code for Romania, an organization that researches and develops digital tools to create a positive societal change in Romania (Figure B). In doing so, we were given the goal of developing a digital tool prototype to aid Romania’s current and future biodiversity challenges.

Our team achieved this goal through the following four objectives:

1. Research the most pressing threats Romania is facing regarding environmental degradation and biodiversity preservation.
2. Generate a list of ideas for potential digital solutions which could address these issues.
3. Choose the most feasible digital tool idea to solve the selected problem.
4. Develop a prototype of a digital tool that Code for Romania can use in the future.

Figure B: *Our team and primary contact, Laura Micle, in the Code for Romania Office.*



Methodology

To complete this project, our team identified threats to biodiversity and habitat loss through online databases and conducted interviews with environmental professionals such as Romanian professors, environmental NGO’s, and a presidential advisor from the Department of Climate and Sustainability.

To gather ideas for digital solutions we conducted online research on current digital solutions that address similar issues. A systematic comparative analysis strategy determined which digital tool solution would best fit within the scope of our project and fit Romania’s most pressing need. The questions used were:

1. Is there a clear audience for this tool?
2. How pressing is the issue addressed by the tool?
3. Would the tool be effective in addressing the issue?
4. How feasible is the creation of this tool?
3. Current methods for reporting human-bear interaction are inefficient
4. Digital tools for animal reporting share three common features

We then graded every digital tool on a scale of 1-5 in each category. We used our systematic assessment to create a prototype in Figma, an online program that allows for creation of user interface and flows. The digital tool we created will be integrated into Code for Romania's existing reporting app: Public Reporter. We chose which fields the user would fill in to complete a report through follow up interviews with wildlife researchers to determine what information is most important for the officials who receive a report and what data the researchers would need.

Findings

The research we did led us to identify four main findings:

1. There are two main causes of habitat loss
2. Habitat loss is affecting the pattern and frequency of human and animal interaction

The two main causes of habitat loss in Romania are lack of management in environmentally protected areas and sweeping land use changes. Urban development has led to increased infrastructure throughout Romania, which often intrudes upon previously untouched ecological corridors. This problem is exacerbated by changes in agricultural policy. Since Romania's accession into the European Union in 2007, farming subsidies have led many farmers to begin clear-cutting forests that provide habitats to Romania's diverse ecology.

Because of habitat destruction, animals are increasingly driven towards human population centers in search of food, led by migration corridors that now intersect human infrastructure. In addition, pollution that is causing global warming is driving bears out of hibernation early. This is causing an increase in human-animal interactions, especially from Romania's sizable bear population. Romania has the largest bear population in Europe, consisting of 6000-8000 bears. In recent years, the number of emergency calls made in Romania about bears has increased tenfold (Bocșe, Personal Comm, 2022).

Yet, despite bear interactions becoming an increasing crisis in Romania,

our research indicates that the current methods for tracking and reporting interactions are completely inadequate. Currently, there is no proper infrastructure for handling bear reports - all reports are made through either emergency services (in the case of a human-bear interaction), or through the local hunting manager (in the case of damaged livestock). These reports are supposed to be sent to the Ministry of Environment. However, interviews indicated that reports are often lost during this process (Retez, Personal Comm, 2022). This is worsened by the fact that none of the reporting process is digitized, which means that creating a report is a tedious process. The bureaucratic overhead of reports is so high, that sometimes farmers do not even report dead livestock, despite governmental subsidies that encourage them to do so (Retez, Personal Comm, 2022).

Once the team uncovered the inadequacy of bear reporting, our primary focus became the digitization of bear reporting across Romania. This directly led to our fourth finding - most digital tools used for animal reporting share three common features. Our team studied multiple digital tools and concluded that the most important fields to include in a bear reporting app are user location, number of animals, and pictures of the animals. We also took inspiration from these tools to include several other fields that would

improve bear reporting and analysis across Romania.

Recommendations

From these findings, we developed three recommendations:

1. Integration of Bear Reporting into Code for Romania's existing app, Public Reporter
2. Digital Centralization of bear reports into a shared database
3. Automatic generation of formal Ministry of Environment reports

These recommendations aim to fix many of the issues we discovered with the current reporting process. Public Reporter is an app in development by Code for Romania that will allow the public to report various problems (noise complaints, illegal parking, etc.) that are then automatically forwarded to the relevant authorities. This provided a convenient platform in which to include bear reporting. Our team produced a prototype of the integration in Figma (Figure C). We also produced a table of information that we determined was important to gather from user reports.

Our second recommendation was the creation of a centralized digital database to be accessed by The Ministry of Environment. We provided guidelines to Code for Romania about who should have access to this database, as well as

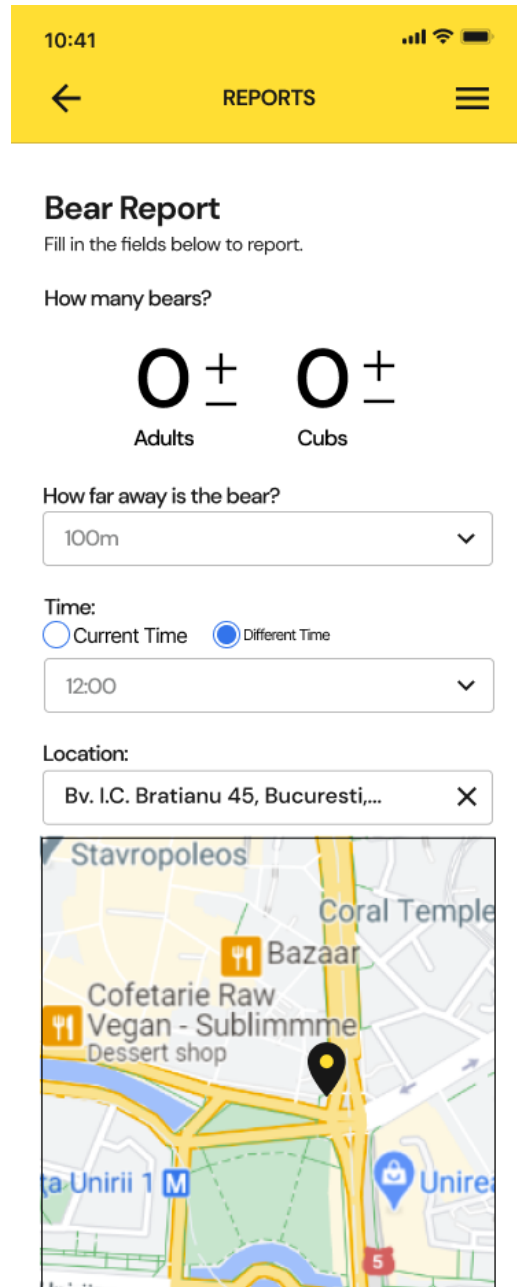
an outline of what types of information should be included.

Our third recommendation is that the database, in combination with a field report from a responder, such as the emergency services or hunting manager, should automatically generate and send the previously paper-based report to the Ministry of Environment. We include a list of fields required for formal reports. We believe that this recommendation will solve one of the most pressing issues we discovered - the loss of bear reporting data between local and federal authorities.

Conclusion

Habitat loss and environmental destruction is a pressing issue in Romania that has led to increased interactions between human and bear populations. Despite this growing crisis, bureaucratic inefficiencies and lack of digitization have left governmental and research organizations with little insight into bear behaviors. In our report, we studied this problem and provided a list of recommendations with the goal of digitizing and modernizing Romania's bear reporting processes.

Figure C: *Initial user interface screen for bear reporting tool in Public Reporter.*



The screenshot shows a mobile application interface for reporting a bear sighting. At the top, there is a yellow header bar with the time '10:41', signal strength, Wi-Fi, and battery icons. Below the header, there is a navigation bar with a back arrow, the word 'REPORTS', and a menu icon. The main content area is titled 'Bear Report' and includes the instruction 'Fill in the fields below to report.' The form consists of several sections: 'How many bears?' with two large circular input fields for 'Adults' and 'Cubs', each with a plus and minus sign; 'How far away is the bear?' with a dropdown menu set to '100m'; 'Time:' with radio buttons for 'Current Time' and 'Different Time', and a dropdown menu set to '12:00'; and 'Location:' with a dropdown menu set to 'Bv. I.C. Bratianu 45, Bucuresti,...'. At the bottom, there is a map showing the current location with a black pin. The map includes labels for 'Stavropoleos', 'Coral Temple', 'Bazaar', 'Cofetarie Raw', 'Vegan - Sublimme Dessert shop', 'Unirii 1 M', and 'Unirea'.

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Introduction

Loss of biodiversity is one of the greatest challenges facing humanity today. The World Wildlife Fund (WWF, 2018) estimates that every year, somewhere between 200 and 2000 species go extinct, a rate which is over 1000 times higher than the natural extinction rate. According to a UN report, urbanization and economic development, which place heavy demands on natural resources like timber, waterways, and oceans, threaten to make almost 1,000,000 different species extinct.

Historically, Romania's desire for economic expansion, land use policies, and lack of oversight and corruption in its government has led to the exploitation of natural resources, thereby threatening much of Romania's natural wealth of biodiversity (Sammon et al., 2022). As a concrete example, Romania is currently losing approximately 38.6 million cubic meters of forest every year leading to the destruction of unique biodiversity and disrupting wildlife habitats (Nicolaiu, 2019). Using digital tools for nature preservation has worked in the past; Between 2010 and 2012, an app called Timby was responsible for every cancellation of illegal logging permits in Libera (*Goldman Environmental Prize*, 2015). Our collaborator, Code for Romania, develops digital tools for Romania's most pressing issues to create a positive societal change and wants to create a digital tool to address environmental degradation.

In the background, we discuss the current state of biodiversity in Romania and the extent to which urbanization and land use changes are threats to biodiversity before examining the impact of political ideologies and policies on the environment. We also introduce our sponsor, Code for Romania, and the important work they have done for Romania in the past. We explained our methods and objectives before presenting findings that there are two main causes of biodiversity loss in Romania: urbanization, land use changes, and poor management of protected areas.

Background

Biodiversity refers to the different kinds of life that make up our natural world, varying from tiny microorganisms to large animals and plants (WWF, 2018). Scientists have identified approximately 1.8 million species, with over 15,000 new

species discovered every year (Kearns, 2010). The discovery of new species enhances our understanding of the world and species interdependence. Biodiversity is essential for the proper functioning of Earth's ecosystems, and several human well-being aspects, including food security, medicine, and clean air and water. It also supports economic activities, such as fishing and tourism, boosting local economies. Moreover, Biodiversity helps humans adapt to the impacts of climate change by storing carbon released into the atmosphere (Shaw, 2018). Therefore, maintaining biodiversity is critical due to its immense benefits to both humans and the planet.

Humans play a significant role in the conservation and loss of biodiversity. Our knowledge, beliefs, and actions can either promote the health and stability of ecosystems or lead to the destruction of natural habitats. Unfortunately, modern human activities driven by economic growth, such as changes in land use and overexploitation of natural resources and forests, have become major drivers of global biodiversity loss (Parliament, 2020). The pressure to meet consumer demands has also resulted in destructive practices like deforestation and mining that contribute to habitat destruction and cause further loss of biodiversity.

2.1 Biodiversity In Romania

Romania has rich biodiversity due to its varied geography and climate. Located in southeastern Europe, it is famous for its natural wonders, landscapes, and forested regions. More than 30% of Romania is covered by forests (Worldbank, 2020), including the largest area of virgin and old-growth forests in Europe (Bondici, 2022), which provide ample habitats for various species to thrive (Worldbank, 2020). The Danube Delta, also located in Romania, is home to 45 freshwater fish species and over 300 other aquatic species. Romania has over 3700 identified plant species, including 23 declared natural monuments (Pupuza, 2019), making it home to diverse ecosystems rich in flora and fauna. To preserve Romania's natural wealth, the European Union (EU) established Natura 2000, a program that identifies and protects over 1500 areas in Romania. Through this program, the government enforces rules to maintain the natural state of these protected areas, safeguarding these vital ecosystems (Biodiversity, n.d.).

Despite the implementation of the Natura initiative and established government

policies, Romania has experienced a decline in biodiversity in recent years. One reason for this is the failure to enforce specific policies, such as the allowance of logging 18 million cubic meters of forest. Unfortunately, due to increased deforestation, 38 million cubic meters are actually being logged (Nicolaie, 2019), leading to habitat loss. For instance, the bear habitats in Valea Ursului (bear valley) have been severely affected by logging activity (Neagu, 2020).

The next sections explore the combined effects of land use policies during the communist regime and the transition to a free market system. The focus will be on the significant habitat destruction, pollution, and climate change caused by the focus on economic growth.

2.2 Communism’s effect on the Environment

The political and economic systems of a society significantly shape the impact humans have on the environment. Communism is a set of political and economic ideologies which aim to create a classless society based on common ownership and communal life. Communism required “intense militarization that emphasized heavy industry” (Mazurski, 1991) with industries such as mining requiring vast amounts of land area leading to deforestation (Okia, 2012). The USSR produced 1.5 times more pollution per unit GNP than the USA (Shahgedanova & Burt, 1994), and “manufacturing processes were not updated to improve efficiency or environmental management” (Mazurski, 1991). Even if a military is not mobilized, heavy militarization negatively impacted the environment during peacetime as militaries released “more than two-thirds of CFC-113¹ into the ozone layer” (Hay-Edie, 2002).

2.2.1 Censorship of information regarding environmental degradation

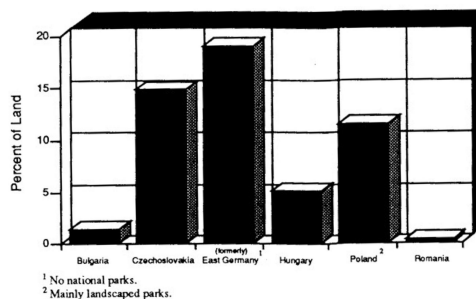
Despite evidence of environmental degradation, “one-party rule inhibited the dissemination of information on environmental degradation” (Mazurski, 1991). Eventually “ecological conditions had become so bad that it was necessary to circulate information about them” but “this information was found mostly in low

¹CFC-113, also known as Freon 113, is a chlorofluorocarbon that causes ozone depletion and global warming (Sullivan, 2011)

circulation scientific publications and focused on questions of human health” (Mazurski, 1991).

Communist governments also used capitalism as a scapegoat for environmental problems, telling individuals that, “poor environmental conditions prevailed in capitalist countries” (Mazurski, 1991). Communist countries also supported the use of capitalism as a scapegoat with policies that looked good “on the books... [yet] were rarely enforced” (Mazurski, 1991). These regulations affected parks and protected lands in Romania. Before communist

Figure 1: Parks and Protected Land in Eastern Europe (Mazurski, 1991)



rule, Eastern Europe prided itself on landscape conservation such as national parks and reserves. However, environmental protection was not held in the same regard by communist regimes so protected areas suffered from environmental degradation (Mazurski, 1991). Figure 1 shows what percent of land in Eastern European countries were parks or protected lands in 1991; Romania had almost none.

2.3 How capitalism encourages the destruction of ecosystems

While communists may have used capitalism as a scapegoat for environmental damage, their claims have some validity. During capitalism, many anthropogenic activities like the expansion of industrial agriculture, logging, drilling, construction, mining, and tourism destroy biodiversity and habitats for profit (Estrada et al., 2022). These anthropogenic activities are prevalent in Romania because of the transition to Capitalism, even in the Danube Delta.

Since the overthrowing of Romanian Communism in 1989, the Danube Delta has been a popular attraction for both domestic and foreign tourists. Capitalism stimulates the economy of villages such as the Sfântu Gheorghe village, where an estimated 80% of locals are involved in tourist activities as their main source of

income (Ivan, 2016). With only around 900 residents, SG village sees close to 10,000 tourists who come to visit the delta every year. The locals often feast on local fish dishes which has had a drastic impact on the fish population in the Danube Delta. The World Wide Fund for Nature states that species such as sturgeon have seen a heavy population decline due to anthropogenic impacts with some species being driven near extinction (WWF, 2018).

Outside of tourism, the transition to capitalism has also allowed for an increased rate of logging in Romania, the process of cutting down trees and transporting them to sell to companies to produce products. Increased logging, legal and illegal, is one of the world's most pressing environmental threats as an estimated 10 million hectares of forests are cut down globally each year (Ritchie & Roser, 2021). Illegal logging in Romania is a rising concern that forests are facing; an investigation by WWF Romania has shown that over 40% of the wood shipments from Brasov and Sibiu counties are illegal (Dumitrescu, 2022). The increase in illegal logging is due, in part, to the increased demand for goods, and one major culprit is Ikea: the largest consumer of wood in the world (earthsight, 2020). The Swedish furniture company receives 10% of its wood from Romania and is the country's largest private landowner (Sammon et al., 2022). Romania has allowed for the destruction of habitats through rapid legal and illegal logging.

Capitalism also brought a new perspective on environmental protection compared to Romania's communist period. Romania had created the Ministry of Environment to "protect the environment and natural resources to guarantee the current and future generations a clean environment, in harmony with economic development and social progress" (Systems, C. n.d). In 2009, Romania implemented a European Union policy called the Natura 2000 Ecological Network as one part of the European Biodiversity Strategy. However, around 78% of the country is not protected under Natura 2000 (Parliament, 2020). In order for Natura 2000 to be successful significant

Figure 2: Sfântu Gheorghe, a popular tourist destination in the Danube Delta



financial support is required, larger habitats require more maintenance which cannot happen without sufficient funds. There have been other policies created by the European Union and implemented by the Romanian government which can be found in Appendix A.

2.3.1 The Importance of Citizen Participation

Legislation is not the only way to protect biodiversity. According to Koontz (2006), “a key component of sustainability and sustainable development is citizen empowerment in decisions shaping social and environmental conditions.” GreenPeace Romania and Agent Green are two Romanian organizations working to protect the environment. GreenPeace Romania has previously protested forest clear-cutting, promoted clean energy use, and raised awareness of the dry Danube bed (Romania, 2022). Agent Green works with The Green European Foundation to protect Romania’s biodiversity. In 2022, Agent Green filed criminal complaints against Sinaia City Hall for illegally building new ski slopes on protected lands (Green, 2022), which suggests there is already some social capital in Romania regarding the environment. However, Mandarano et al. (2010) states the future of social capital is in “digital social capital” which is “the process of building digital communities through planning practice, specifically public participation processes that embrace Internet tools.”

2.4 Digital Tools: A Contemporary Solution to Environmental Degradation

Digital tools have become a popular way to address environmental challenges because they can democratize environmental data. This could prove useful in the Romanian context because many environmental challenges stem from a lack of transparency about environmental data. This problem has plagued Romanian digital tools in the past. In 2016, the Romanian government released an app called “Forest Inspector” that allowed the public to view data about logging shipments in real time which dropped forestry crimes in Romania by 47% within a year (roinsider, 2019). However, the Romanian government cut many of the features that made Forest Inspector effective. In 2019 Romanian courts ruled that the

Forest Ministry would pay almost 100,000EUR to the company that they had partnered with to create the tool, citing their refusal to provide up-to-date information (roinsider, 2019). Among these features was the ability to see up-to-date harvest authorization information, which allowed the general public to alert authorities to illegal operations (Agency, 2020). Forest Inspector shows that digital tools can effectively mobilize the public to solve environmental problems if the institutions behind them do not work against them.

One conservation tool success story is Timby. Created to combat illegal timber harvesting in Liberia, the tool allows the public to report events using a mobile app (Timby, n.d.-b). Between 2010 and 2012, Timby was responsible for every cancellation of illegal logging permits in Liberia, saving an estimated 2,000,000 hectares of forest (Timby, n.d.-a). By specifically targeting public activists and promoting public intervention, Timby was effective at treating illegal logging. Not all tools target the public, however. For example, according to the British Trust for Ornithology, over the past 30 years over 20,000 satellite tags have been attached to various species of birds. These satellite tags then report to Movebank, an online platform helping thousands of researchers and wildlife managers worldwide to manage, share, analyze and archive animal tracking and other animal-borne sensor data (Wikelski, Kays, & Davidson, n.d.). Because of the creation of Movebank, over 5 billion GPS location reports are now freely available online to experts, leading to the publishing of almost 8000 academic reports over the last 10 years (Wikelski et al., n.d.). By targeting academics and experts and democratizing access to data, Movebank was able to revolutionize how bird species research is done. These examples illustrate that there is no specific formula when creating digital tools - rather, there are many options that may all be effective, and research must be done to determine the “right fit” for every use case.

2.4.1 Digital Tools: Rules to Live By

Many of the challenges and problems encountered in the development of digital tools are not novel. In *Digital Technology and Human Development: A Charter for Nature Conservation*, Maffey, et al. lay out a “Digital Conservation Charter” which aims to guide the development of conservation tools by identifying five key problems that often plague digital tooling (Maffey, Homans, Banks, & Arts, 2015):

First, technology often becomes outdated and without a plan to ensure the tools last, they may become irrelevant. Second, organizations often resolve problems that other tools may already address. Using existing tooling may be better in the long run, even if it does not perfectly fit the use case. Third, tools often over-generalize. While generic tools may have a larger area of effect, Maffey suggests that “[for a digital tool] to work, it has to have relevance for both the project and communities it is deployed in.” Fourth, conservationists should be aware of shifting the problem. Tools that solve an issue in one area may create a different issue in another area. Finally, the paper warns not to equate online impact to offline impact. While it can be easy to get supporters online, this may not equate to successful engagement offline. Using these identified problems, Maffey et al. propose a “digital conservation charter” of 14 key questions to ask about digital tool development. These questions range from understanding scope - “*Have the community of groups or individuals identified a problem that an appropriate form of technology may be able to add?*” to implementation - “*Will the implementation be piloted on a small scale?*”, and evaluation “*How will the impact of the initiative be measured—both environmentally and socially?*” (Maffey et al., 2015). By answering these questions, a digital tool can be developed that avoids past pitfalls and has good user engagement and longevity to curb the growing Romanian environmental crisis.

Code for Romania in collaboration with its partner company Civic Labs conducts research, develops, and evaluates digital solutions that solve some of Romania’s biggest social, economic, and environmental issues. Every year, Code for Romania develops solutions for Romania’s most pressing issues. In 2023 Code for Romania decided to develop a digital solution for the protection of biodiversity with a focus on “reducing the harmful impact of environmental degradation by developing digital tools that contribute to the protection of nature in all its forms.” Code for Romania asked our team to research environmental problems in Romania and develop a digital tool prototype to solve one of the problems. The following chapter describes the methods we used and the objectives we achieved in pursuit of this goal.

Methodology

The goal of this project was to develop a digital tool prototype to aid Romania's current and future biodiversity challenges. Our team achieved this goal through the following four objectives:

1. Research the most pressing threats Romania is facing regarding environmental degradation and biodiversity preservation.
2. Generate a list of ideas for potential digital solutions which could address these issues.
3. Choose the most feasible digital tool idea to solve the selected problem.
4. Develop a prototype of a digital tool that Code for Romania can use in the future.

This chapter explains the methods we used to determine a digital tool that can highlight the loss of biodiversity.

3.1 Objective One: Research the most pressing threats Romania is facing regarding environmental degradation and biodiversity preservation

To better understand biodiversity loss in Romania, we first researched factors that are contributing to it. We researched an online database and EU reports that provided us with ecological information on the current state of animals and their habitats in Romania. We then interviewed non-governmental organizations, professors that had backgrounds in wildlife ecology, and a state advisor from the Romanian Department of Climate and Sustainability.

The team identified several resources that enabled us to better understand recent environmental developments in Romania that contributed to biodiversity loss. The European Union reports we identified provided the team with a comprehensive breakdown of species populations over time. The database we identified provided us with insight into the policies created to combat biodiversity

loss. The database also gave us lists of Romania’s protected areas and the size distributions of the protected area networks as well. For both reports and online databases, we looked at all of Romania and its ecosystems with wildlife loss. The team consulted one database and two reports focused on biodiversity loss (Appendix B).

The team developed specific criteria for our research. In databases, we looked for quantitative information that gave us percentages of the most affected species impacted by biodiversity loss. We also focused on threats to habitats to understand biodiversity loss over time. For reports, we looked at case studies of species where we analyzed databases and reports that specified the areas in Romania that had the biggest decline in species population. We looked at the top 5-7 species that were impacted most by biodiversity loss. We only looked at published reports written after 2009 and limited searches on databases from 2009 to the present. From these reports and databases, we identified underlying factors for the causes of biodiversity loss.

3.1.1 Interviewing NGOs, Professors, and Romanian Government Officials

Based on findings from our online research, we set up interviews with environmental experts to gain a clearer picture of what is causing biodiversity loss and how the government is addressing biodiversity. The team identified two NGOs, two professors, and one government official based on their involvement with environmental activities in Romania. Below is a table of NGOs, professors, and government officials we interviewed.

Our team conducted five semi-structured interviews from March 27th to April 5th that lasted 30 to 45 minutes. We used semi-structured interviews because this allowed for follow-up questions. The general set of questions for each interview was about biodiversity in Romania and their experience with digital tools. There were slight differences in questions for each interview. Prior to the interview, we obtained verbal consent for the interview and the use of obtained information in our report (Appendix C). While the team asked all respondents questions about biodiversity and digital tools, we tailored questions for members of NGOs based on their project expertise and for professors based on their research interests (Appendix D).

Table 1: NGOs, Professors, and Government Officials Interviewed

Organization	Name	Title	Date
World Wildlife Fund (WWF)	Orieta Huela	CEO of WWF Romania	March 27th
Asociației Parcul Natural Văcărești	Dan Barbulescu	Director	March 28th
Universitatea din București	Razvan Nita	Professor	March 29th
Department of Conservation Biology, Ohio University	Viorel D. Popescu	Professor	March 29th
Departamentul Climă și Sustenabilitate	Alexandra-Maria Bocșe	State Advisor	April 5th

3.2 Objective Two: Generate a list of ideas for potential digital solutions which could address these issues

After determining the primary threats to Romania’s biodiversity we gathered potential digital tools to address these threats. This list was generated from multiple sources; we conducted online research of similar digital tools and by interviews with environmental experts. We researched how the United States is addressing similar challenges using digital tools because of its advanced approach to using digital technology to address environmental and biodiversity concerns. These existing digital tools served as inspiration for other potential tools that would be relevant in Romania and reflect the issues we had found from objective one.

Through a combination of research and interviews, we generated a list of digital tools that are responsible for addressing environmental/biodiversity issues by collecting data or providing information (Appendix E). Furthermore, the interviews and tool analysis also helped us identify the target audience of the tool. Using the information we gathered, we established specific criteria to evaluate the effectiveness of the digital tool we planned to develop. These criteria included the ability to collect real-time data to inform decision-making, facilitate communication between the public and the authorities, support the development of conservation strategies and action plans, and most importantly, enhance public awareness.

3.3 Objective Three: Choose the most feasible digital tool idea to solve the selected problem

We used a systematic assessment strategy to compare the different digital tool ideas we identified through objective two, to decide what kind of digital tool prototype to create (Appendix E). This strategy involved compiling key criteria/questions and then rating how each tool performed in each category on a scale of one to five. We used the four questions below when comparing our digital tool ideas:

- Is there a clear audience for this tool?
- How pressing is the issue addressed by the tool?
- Would the tool be effective in addressing the issue?
- How feasible is the creation of this tool?

We then met as a team and with our collaborator to score each category for the digital tools we had identified and then validated our reasoning based on analysis from our interviews. After adding the digital tool's score for each category, we calculated the resulting score for each digital tool. We then compared digital tools to identify which would be the best fit to accomplish our goal (Appendix F).

3.4 Objective Four: Develop a digital tool prototype that Code for Romania can use in the future

After we determined that the best digital tool would be a reporting tool, Code for Romania informed us that they had already worked on the proof of concept for a similar application called Public Report. This app acts as a centralized way to report a number of different problems including noise complaints, water issues, and cars parked illegally. This meant that we did not have to do some of the more tedious work such as deciding what colors and fonts would be used in our application and we could focus on more important issues such as developing user flows and creating example screens to integrate into Code for Romania's pre-existing application.

3.4.1 Developing example user flows and creating example screens

The first step in developing our recommendations for Code for Romania was creating some example user flows. A “User flow is the path taken by a prototypical user on a website or app to complete a task” (Optimizely, n.d.). Developers create user flows to determine how their users should interact with the app and to make sure it is accessible. We did this by assessing how the Public Report application flows for other types of reports and then applying these to the needs of a digital reporting tool. After we completed our user flow and created a list of questions that should be included in our report we had a final interview with Gabriele Retez who is a researcher at WWF in order to make sure we had the required information for the report Appendix C.

After developing our user flows we determined what additional screens our application required. We did this by determining which steps of the flow were on the same page and which steps required entirely new pages. After adding what was necessary to pre-existing pages, our group made the new pages. We did this by looking at what colors and fonts the Code for Romania team used on their initial project file. After that, we took one of the similar report pages and based our report page on it.

Findings

Our research revealed that habitat loss is the primary threat to biodiversity in Romania. We have four main findings:

1. There are two main causes of habitat loss.
2. Large carnivores are interacting with humans more on a more regular basis due to habitat loss.
3. Current methods for reporting human-bear interaction and identifying individual bears are inefficient.
4. Digital tools for animal reporting share three common features.

The first three findings came from interviews we conducted with people who worked at NGOs, Professors, and the State Advisor for the Department of Climate and Sustainability of Romania. Our fourth and final finding came from our research into what common features digital reporting tools currently have and what could be improved in future digital reporting tools such as the one we have designed for Code for Romania. Appendix E contains ideas for digital tools compiled during our interviews.

4.1 There are two main causes of habitat loss

During our interviews we found several causes of environmental degradation and biodiversity loss including deforestation, logging, management issues within protected areas, and land use changes. The commonality is that all processes lead directly to habitat loss, making it the primary environmental threat in Romania. The two main contributors to habitat loss were management issues within protected forests and destructive land use changes in Romania.

4.1.1 Lack of enforced management in protected areas

Through our interviews with professors, NGOs, and national experts, we discovered that a major contributor to biodiversity loss is the weak planning and management systems of protected areas. The Romanian government has established several programs to protect land areas that they have deemed important to protect its natural state and has delegated responsibility for management of these lands to NGOs. However, insufficient policies for managing protected areas have been a contributing factor to habitat loss in Romania. According to our interview with Mihai-Razvan Nita, a professor from the University of Bucharest, although Romania is part of the EU and its legislation largely conforms with EU standards, the success of the policy depends on how effectively they enforce legislation. Despite very little planning, in 2016 the government established Agenția Națională pentru Aree Naturale Protejate (ANANP) which took control of all of Romania's protected lands . According to Viorel Popescu and Orieta Huela, implementing ANANP required NGOs to abandon the management process of the protected areas to which they were previously assigned. According to Viorel Popescu

ANANP had sufficient funds for the implementation of legislation required by the government but they were not used efficiently. This led to an increase in deforestation, unplanned urban development, and disruptive human activities in protected areas which is a contributor to biodiversity and habitat loss in Romania.

4.1.2 Land use changes

Urban development is a key danger to biodiversity in Romania. After communism ended, Romania developed economically. It created infrastructure such as highways and roads, as well as tourist-focused activities. Ms. Huela explained that towns like Baile Tusnad, which are focused on eco-tourism, are expanding their ecological corridors resulting in the destruction of natural habitats. Ecological corridors protect undeveloped land and are critical components of wildlife habitat because they enable wildlife's seasonal migration. Development gradually encroached on land in protected areas (V.Popescu, personal communication, March 29th, 2023). Infrastructure development in Romania has also increased the demand for transportation. Renewable energy development has also had negative effects on biodiversity. Energy that has been labeled as "green", such as dams and wind power, has been known to disrupt the habitats of many species. Orieta Huela, from the World Wide Fund for Nature, stated that hydroelectric plants can disrupt the movement of aquatic species up and down the river while Viorel Popescu stated that the cumulative effects of hydroelectric and wind power are currently unknown by the government. Since hydroelectric and wind power are considered "green," the government approves the construction of plants in protected areas, which can lead to land damage, destroying areas once covered in plant species.

Orieta Huela and Alexandra-Maria Bocșe explained that the EU currently provides subsidies to farmers based on how much land they have plowed. According to Orieta Huela, farmers take advantage of subsidies by clear-cutting forests on their property and surrounding land they do not own but which has unclear property lines. This destroys important transition zones and temporary wetlands between towns and forests that are important to biodiversity and could be water sources. Ms.Heula explained that transition zones are important to wild animals because of the food sources and the habitat they provide. Without transition zones, there is a higher chance that wild animals will enter towns in search of food

resulting in an increasing interaction between humans and wild animals, which could be hazardous.

4.2 Habitat loss is affecting the pattern and frequency of human and animal interaction

Alexandra-Maria Bocșe, Orieta Huela, and Viorel Popescu acknowledged that the significant loss of habitat is directly affecting animal behaviors and increasing human-animal interaction. According to Bocșe, Romania gives priority to human-bear interactions due to its frequency and the need to protect bears, given their crucial role in maintaining a healthy ecological balance. Ms. Huela and Popescu indicated that as cities expanded, humans started interfering with bears in their natural habitats and started encountering them more frequently. As a result, the number of emergency calls containing the word ‘bear’ increased over the past years indicating a growing trend of human-bear interactions (Bocșe, personal communication, April 5th, 2023). In 2021, Barna Tancos, the Minister of the Environment, stated, “The number of bear-related calls on the 112 emergency number has reached almost 6,000 between 2016 and 2021, a tenfold increase since 2016” (Sarány, 2021).

Ms. Huela argued that “... bear(s) can easily be habituated when hunters are supplementing food, especially when the food is placed in the vicinity of the villages.” Subsequently, bears are more attracted to populated areas and become “problem bears.” This practice poses a risk to human safety due to the uncertainty of the bears’ actions when they enter areas inhabited by humans. She added that “the hunters take advantage of the problematic bears to hunt normal bears.” Over 1400 bears have been killed since 2016, which poses a threat to biodiversity as a thriving bear population is indicative of a healthy and productive forest environment.

Global warming has also altered bears’ natural behaviors. Alexandra-Maria Bocșe stated that although industrial emissions have decreased by the 21st century, transportation emissions and air pollution have increased due to the rise of cars, public transportation, ships, and planes. The resultant pollution has decreased the growth rates of plants and trees in forests, damaging the habitats for animal and plant species in Romania. The change in climate brought about by air pollution

also directly impacts animal behavior. Bears, for instance, are becoming more active during winter months when they usually hibernate (Bocșe, personal communication, April 5th, 2023). She added that in mountainous areas such as Sinaia - a town and mountain resort in Prahova county - bears are emerging from hibernation earlier, requiring visitors to exercise more caution because of the increased risk of human-bear interaction. According to Bocșe, Romania does not have an exact count of its bear population but estimates it to be between 6,000 - 8,000 bears. To protect and preserve this species, as well as minimize human-bear interactions, she emphasized the need for effective monitoring and reporting of bears.

4.3 Current methods for reporting human-bear interaction and identifying individual bears are inefficient

One of the most relevant findings was that the system in Romania for reporting human-bear interaction is plagued with inefficiencies. To report a bear sighting under the current system, a member of the public must first call emergency services who will then attempt to scare off the bear. If this fails, emergency responders must get approval from emergency services, the mayor of the town, and the local veterinarian to neutralize (kill) the bear. No matter what action is taken, emergency services must then file a formal report with the Ministry of the Environment. According to Alexandra-Maria Bocșe, this often takes the form of a paper report that the emergency services mail to the Ministry. This form of reporting often gets lost in transit, which leaves the Ministry of Environment with no way to accurately track the number of bears in Romania, partially because there is no system in place to differentiate multiple reports that refer to the same sighting. Another major problem brought up by both the WWF and Alexandra-Maria Bocșe is that there is no easy way to identify when the same bear repeatedly interacts with humans. This is important because a small subset of “problem bears” - generally those that are more acclimated to human interaction and are more likely to seek food or shelter in human areas - pose a greater risk to humans and are more often reported interacting with humans. Problem bears often require more extreme action to be taken, whether neutralization or capture and

release into a dedicated sanctuary area. Without a good idea of which bears are “problem bears,” it becomes much harder for emergency services and the Ministry of the Environment to decide what type of action is warranted.

Direct bear sightings are not the only type of bear report. According to Gabriele Retez, a wildlife ecologist expert at WWF Romania, reports of livestock and farm damage are much more common than direct sightings. While these sightings do not directly involve seeing the bear, they are equally valuable when tracking bear movements and behavior. Mr. Retez explained that livestock and damage reports do not go through the same process as emergency reports. Livestock reports go through the local hunting manager and are then supposed to be elevated to the Ministry of Environment. However, he went on to explain that many livestock reports that contain crucial information are lost because they are either not reported to the Ministry of Environment or are not reported by farmers in the first place. He believes that this is because the process of reporting is tedious for both farmers and hunting managers - “Nothing is digital, and that’s the problem . . . often the reimbursements farmers get for livestock are not worth the paperwork.” He believes that digitizing livestock reporting methods could prove extremely valuable for both the Ministry of Environment and NGOs that handle bears in Romania.

4.4 Digital tools for animal reporting share three common features

Because officials are interested in a streamlined digital bear reporting tool, the team researched and identified apps that allowed user reporting of animals to the authorities. We explored three main animal reporting apps: GrizzTracker, Uite Barza, and Sharktivity. These apps were selected because their main feature is the ability of the user to report a finding; whether it is sighting an animal directly, the animals’ nest/home, or evidence of the animals’ presence through scat or tracks. All the digital tools we compared have the ability to collect the location of the report/reporter, to include the number of animals, and to have the option of including notes or pictures (Figure 3). Each app’s locating method is displayed in Table 2.

The location feature is especially helpful so that, for example, users can avoid

Table 2: Investigated digital tools and their locating methods.

App Name	Locating Method
GrizzTracker	Allows the user to pin the location on the trail where the sighting occurred.
Uite Barza!	Allows the user to select the location using a search feature similar to Google Maps.
Sharktivity	Does not allow the user to choose the location, but instead automatically takes the user’s position using GPS

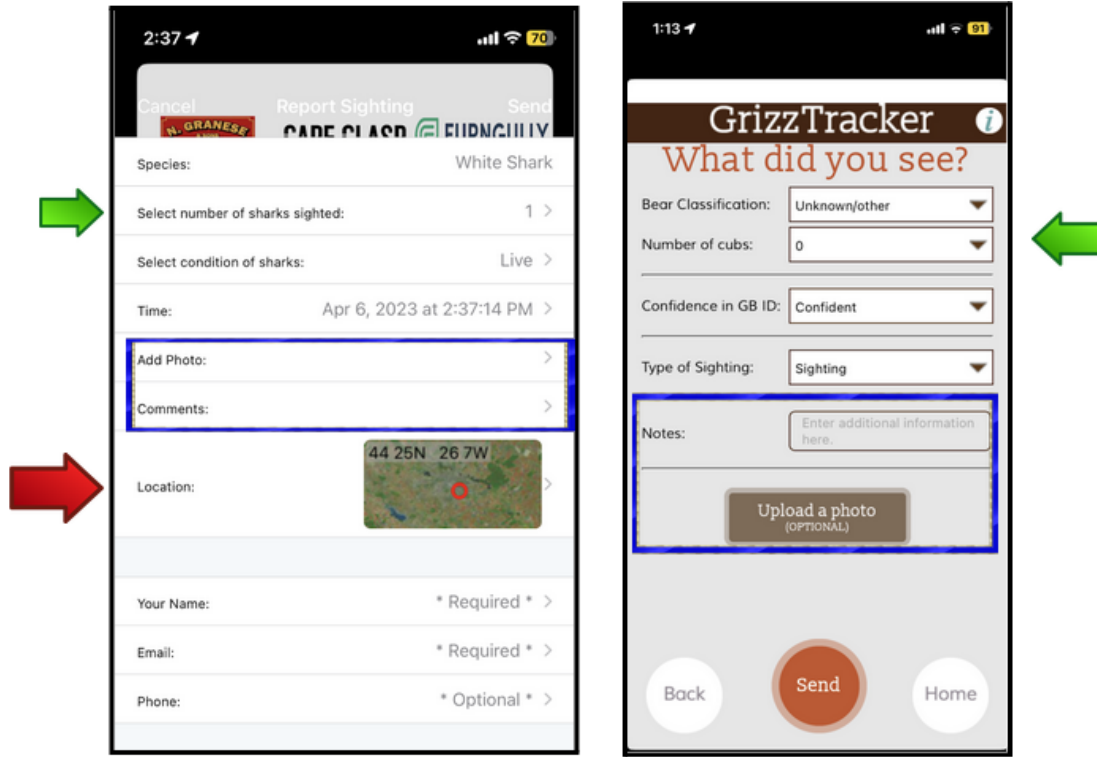
beaches with shark sightings, they can help baby storks that fell out of their nest in the middle of the city, or let officials know when a bear is in town. According to Gabriele Retez the location of each report is key to the proper official receiving the report because it allows them to not only go to the location to manage the animal, but it also provides more accurate data on where animal clusters are located. It also allows researchers, scientists, or officials who receive the data to record trends in both population size and movement for every animal report (Beck, 2020). Alexandra-Maria Bocșe emphasized the importance of this feature in a bear reporting app, because it may prompt the closure of hiking trails due to a rapid increase in bear reports and potentially avoid a bear-human conflict.

A second feature that is important to include in tracking/reporting apps is the ability to report the number of animals sighted in an individual report because this provides a different weight to the report the official receives. For Uite Barza!, it is important that the number of storks seen is included in the report because the app’s data is used to help Romanian Ornithological Societies (SOR) track the conservation status of the species. The white stork is a protected species, and the app was created with the intention to track and measure the population size of the protected species. Also, Sharktivity requires the use of a location with each report because it may help officials understand the migratory habits of white sharks. Another example is a Grizztracker report of multiple bears in a town, indicating to the official a higher level of urgency than a single bear sighting. The number of reported animals on Grizztracker can also inform the official if there is a lone adult bear, a mother bear (sow) and cubs, or a single cub that is in close contact with human activity. Mother

brown bears pose a greater threat to humans than a lone adult because sows are more aggressive and will attack in defense of their cubs. In fact, seventy percent of human deaths from grizzly bear attacks are from a mother grizzly protecting her cubs (Herrero, 2015).

The third common feature among digital tools is the ability to include pictures or notes on the sighting in the report. Uploading pictures gives each report a level of legitimacy and allows the official to confirm the sighting. While Sharktivity allows users to submit reports that appear on a map visible to users, it remains an unconfirmed report until the New England Aquarium completes the confirmation process, which requires a picture. Uite Barza also recommends adding a picture to help confirm the report, as the user may mistakenly identify a random bird's nest as a stork nest and would then not be a valid report. For Grizztracker, a picture is also suggested, but not required as bears are an easily identifiable animal for users. In our interview with Retez, he explained that pictures are important since it will help officials identify if the reported bear is a repeat offender, and therefore a problem bear, or a one time perpetrator of interacting with humans. Bears often have identifiable marks such as scratches, chunks of missing fur, or scars; this will help officials identify a bear.

Figure 3: Sharktivity (left image) and GrizzTracker (right image) reporting pages and key features - number (green arrow), location (red arrow), and optional fields (blue block)



(a) Sharktivity Input

(b) GrizzTracker Input

4.5 Discussion

During our interviews, we found that the two main causes of habitat loss that arose mirrored findings from our background research. Our interviews with Viorel Popescu and Orieta Huela confirmed that Natura 2000 and other environmental policies have failed in Romania due to a lack of funding and poor management. Additionally, our interviews with Orieta Huela and Dan Barbulescu gave us a deeper understanding of how the government had initially entrusted NGOs with the protection of protected areas but later revoked this privilege with the creation of ANANP. The information from our interviews also helped to bolster our understanding of how urbanization and land use changes have negatively impacted the environment.

Our research revealed that habitat loss in Romania is driven by factors such as poor management of natural protected areas, increased urbanization, and land use changes. This has resulted in an increase in human-bear interaction, which has become a pressing issue. Additionally, the combined effects of industrialization, urbanization, and land use changes, both past and present, have contributed to global warming, altering the hibernation pattern of bears and further exacerbating the human-bear interactions problem. This poses a safety risk to humans in the vicinity and can lead to conflicts that increase bear mortality, thus threatening the bear population. Bears are an important species in Romania as they can be used to track natural ecological corridors and are a valuable barometer of global warming through monitoring their hibernation patterns.

We determined that a digital tool related to bear reporting would be important to the Romanian population, and feasible to implement. However, there are still some other tool ideas that were brought up during the interviews that we think could be interesting for our collaborator to keep in mind for the coming year. For instance, ticketing and mapping apps for national parks have been developed to increase awareness of biodiversity within the park. Examples of such apps can be found in places like New Hampshire. Additionally, satellite imaging tools could be very useful for the Romanian government in order to determine where temporary wetlands are or why forests are dying. These applications would require more research about how different forest afflictions or temporary wetlands could be identified, but this falls outside of the scope of our project and outside of our time constraints. A table of these ideas can be found in Appendix E.

Recommendations

Throughout our research, the most common theme was the need for digitized bear reporting processes. Therefore, after careful consideration of our findings and discussions, the team created suggestions for Code for Romania on how to support the bear reporting tool prototype and what the subsequent stages for the tool could be. These recommendations include:

5.1 Integration of Bear Reporting into Code for Romania’s existing app, Public Reporter

Code for Romania conducted research and found that individuals are much more likely to use and report problems on an app if all reports are centralized into a single resource, rather than spread across separate apps that users must download. Public Reporter is a centralized app being developed by Code for Romania that allows the public to report various problems such as illegal parking or noise disturbances to the appropriate authorities. We recommend adding a bear tracker component to the preexisting Public Reporter App to facilitate reporting and engagement among the public.

The team has created a mockup of what a potential integration would look like in Figma (Appendix G). Our interviews and review of other apps led to a comprehensive list of included and excluded features. In particular, we included features that specifically address shortcomings of existing reporting methods (Appendix H). To combat identified problems with analysis in Romania’s current reporting methods, most of the data collected in the proposed app is categorical in nature, rather than free-form user input. Categorical data allows easy statistical analysis and eliminates the need for manual classification of reports.

When designing the final mockup of the app, we divided reporting into two categories: information critical to the report - date, time, location, number of bears - and information not necessarily critical to the report but useful in analysis - photos, videos, actions of the bear, and circumstances surrounding the sighting. Critical information was largely informed by the existing reporting process. Without information about the time, location, number of bears, and urgency of the situation, reports are of little use to emergency services. We also felt that it was important to redirect the user to a proper emergency line if they believed that the bear posed an imminent threat. Non-critical information is not required by emergency responders but is useful to those conducting further analysis of bear sightings and activities. Non-critical information was mainly informed by the interviews we conducted. For example, while pictures or videos of the bear may not be as useful to emergency responders, our research indicated that this information may be helpful to determine individual problem bears (Retez, Huela, and Bosce,

Personal Comm.). We did not want to put the user in harm's way by asking them to collect unnecessary data (for example, capturing pictures of the bear). Therefore, we recommend that all fields not critical to emergency services be optional as to not endanger the user when reporting a sighting.

5.2 Digital Centralization of bear reports into a shared database

To obtain a better understanding of the true quantity and severity of human-bear interactions, the team's second recommendation is that any created digital tool feeds into a shared database that emergency services and the Ministry of Environment can readily access. A common theme picked up in many of our interviews was that a major problem inhibiting bear-report data analysis is the lack of centralized access to all bear-report data. Feeding all data into a shared database that authorities can easily access will eliminate manual reports and analysis. It is also easier to perform programmatic and statistical analysis on centralized data. By maintaining a shared, centralized database that is automatically updated with bear reports, the Ministry of Environment will be able to gain accurate, real-time insight into the bear problem and develop more effective methods for tracking and handling bears in the future. The shared database should contain all fields that are contained in app user reports (Appendix H). Additionally, it would be beneficial if "expert" reporting was integrated into the same database for the reasons discussed in section 4.3. Expert reports should be added through a separate authenticated portal because they are made by trained experts, rather than the general public. Expert reports should include things like livestock reports, which are made by the local hunting managers rather than the general public. Expert reports have the benefit of being able to include more in-depth questions than normal reports. A list of fields that should be included for expert reports in the database can be found in (Appendix I).

The database should not be available to the general public because this could encourage people to seek out bear sightings from the database. However, it is imperative that the data is made freely available to more than just governmental organizations like the emergency services or Ministry of Environment - primarily, NGOs and researchers that study bears or wildlife. In the background, we

highlighted that by allowing researchers to access bird migration data, Movebank inspired the creation of nearly 8000 academic reports. We believe that a properly designed and implemented bear database in Romania could have a similar impact on large carnivore studies - not just in Romania, but around the world.

5.3 Automatic generation of formal Ministry of Environment reports

Instead of the existing reporting method, which consists of paper reports mailed or emailed to the Ministry of Environment (Alexandra-Maria Bocşu), we propose that a new formal reporting method is integrated into Public Reporter. We believe that the new reporting method should consist of a way to automatically link user reports from a centralized database together into formal reports. User reports, combined with a summary of action taken against the bear (as described by emergency responders), would automatically be uploaded to the Ministry of Environment. This would eliminate the need for manual submission, which, according to the presidential administration, would be more time efficient for emergency services.

Conclusion

Code for Romania wants to create a digital tool that would “protect nature in all its forms.” We conducted extensive research and interviews to narrow this tool’s purpose to a specific issue. We found that there is a growing problem of human-bear interactions near the Carpathian Mountains and that the current reporting process is outdated, inefficient, and unreliable. Our team identified the need for a new digital solution for this process and provided recommendations to Code for Romania. Since our collaborator had previously worked on a universal, national reporting tool, it was determined that integrating our solution was the best course of action because creating an entirely new app would be a waste of resources. We created a list of recommendations for Code for Romania, outlining the information that the reporting app should collect and how it should be integrated into the preexisting proof of concept via a prototype. Although our app will not be an immediate solution to this problem, it may help it in the future as more data on bears are collected. We

believe that our recommendations will provide Code for Romania with a fast and effective way to report bear sightings and help prevent life-threatening bear and human interactions.

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Appendix A: Environmental Conservation Policies

Policy	Goal	Description
Convention On Biodiversity	Organization of nature protected areas and protection of high value species	Approved in 1994 which identifies direct threats to biodiversity aimed to secure preservation of biodiversity
Natura 2000	The goal of the network is to protect and preserve the species and habitats that are crucial to their respective communities.	Habitats Directive: The directive of conservation of habitats and wild flora and fauna, it ensures the protection of rare or threatened animal or plant species Birds Directive: aims to conserve all wild birds by creating rules for their protection and management which includes their nests habitats and eggs
National Environmental Protection Strategy	Set out the national objectives regarding the National Environmental Protection Plan	The first official document in 1992 that addressed national objectives. Split into two categories: A review of natural resources and relation to economy and principles of environmental protection
Junk Programme	Programme aims to cleanse the national fleet of heavy polluting vehicles, which will reduce greenhouse emissions, and will reduce air pollution.	Government environmental policy tool designed to offer vouchers to for every old environmentally harmful scrap the voucher is used towards the purchase of a new car.

Appendix A: Environmental conservation policies and their goals

Appendix B: Biodiversity Research Resources Table

Name	Type	Distributor	Description
Biodiversity Information System	Database	Biodiversity Information System for Europe	Contains the data and information on biodiversity in Europe as well as policies that have been put in place to help prevent the loss of biodiversity in Romania and the progress that has been made on them.
Forest Biodiversity In Europe (5/30/222)	Report	European Forest Institute	Details how to effectively limit the loss of biodiversity in Europe including information on the time lag between the loss of biodiversity and the implementation of new policies to help combat it.
Regional Assessment Report on Biodiversity for Europe and Central Asia	Report		This report focuses on the production, consumption, and economic development of biodiversity.

Appendix B: Databases and Reports on Biodiversity.

Appendix C: Interview Consent Form

We are students from Worcester Polytechnic Institute, Massachusetts, USA working with Code For Romania to research and develop a digital tool prototype to aid Romania in combating its current and future biodiversity challenges. We are conducting interviews to determine the current environmental issues in Romania. This interview will take approximately 30 minutes. Your participation is completely voluntary, and you may stop the interview at any time or refuse to answer any question we ask. This interview is confidential—no names or identifying information will appear in any project reports or publications unless you agree to have your name published.

With your permission, we will be recording this interview and using the recording for transcription purposes. The transcription will be used for note-taking and/or evidence in our report.

Should you have any questions or concerns upon completion of this interview, we can be reached at gr-coderomania-d23@wpi.edu. For more information about this research or about the rights of research participants, please contact Melissa Butler and/or Melissa Belz at mbutler@wpi.edu or mbez@wpi.edu respectively.

[if asking for permission verbally prior to the start of the interview]

Do you consent to this interview?

Do you consent to having this interview recorded?

Do you consent to the inclusion of identifying information in our report?

Do you consent to the inclusion of your name in our report?

Appendix C: Interview consent question asked before each interview

Appendix D: Interview Questions

1. Can you tell us a bit about yourself and your professional experience?
2. I understand WWF does work in the Carpathian mountains to protect large carnivore populations, can you tell us a little more about those efforts?
 - (a) Are there any other WWF projects you would like to talk about?
3. In our research we found that WWF has worked with NGOs in the past on projects like SaveGreen and Open Borders for Wildlife in the Carpathians. Can you describe the process of working with other NGOs?
4. What would you say are Romania's biggest concerns regarding biodiversity and the lack of environmental protection?
 - (a) Are any of these issues long-running or have the problems appeared more recently?
5. Can we go a little deeper on the subject of ----- (insert key topic here)?
 - (a) Is WWF doing any work around this issue?
 - (b) What are the challenges WWF faces in relation to this issue?
 - (c) What are the authorities doing to address this issue?
6. Do you have any experience with any digital tools that help the environment or support those working on the environment?
 - (a) (If yes) How beneficial do you think digital tools are?
 - i. And what are their limitations?
 - (b) Can you think of a possible digital solution that could help address any of the issues we've talked about today?
 - i. Who do you think the audience for such a tool would be?

Appendix D: Interview questions for Orieta Huela, CEO of WWF Romania

1. Can you tell us a bit about yourself and your professional experience?
 2. Vacaresti Nature Park is a fairly new park. What have the biggest challenges been with it since it was established?/ In your view, what are Romania's biggest concerns regarding biodiversity and the lack of environmental protection?
 3. Does Vacaresti Nature Park collaborate with other NGOs? If so, why and what is the process? If not, why not / what are the hurdles to doing so?
 4. Do you have any experience with any digital tools that help the environment or support those working on the environment?
 5. What kind of tool would best assist you in the future?
 - (a) Who do you think the audience for such a tool would be?
 6. If anything could be changed in Romania tomorrow in regards to the environment what do you think that should be?
 7. Would you be able to put us in contact with anyone else in this field for interviews to help us with our research?
-

Appendix D: Interview questions for Dan Barbulescu, Director of Vacaresti Nature Park

1. Can you tell us a bit about yourself and your professional experience?
 2. You have done extensive research on the conservation of biology, what would you say are Romania's biggest challenges regarding biodiversity loss?
 3. Can you tell us a little bit about the research you have done on nature based solutions in urban areas?
 4. Do you believe a digital tool of some sort could help combat these biodiversity issues?
 - (a) What would a tool like this target and who would the audience be?
 5. If anything could be changed in Romania tomorrow in regards to the environment what do you think that should be?
 - (a) App Idea?
 6. Would you be able to put us in contact with anyone else in this field for interviews to help us with our research?
-

Appendix D: Interview questions for Razvan Nita, Professor at University of Bucharest

1. Can you tell us a bit about yourself and your professional experience?
 2. You have done extensive research on the conservation of biology, what would you say are Romania's biggest challenges regarding biodiversity loss?
 3. Recently, you have done a research project about terrestrial carnivores in the Carpathians, would you be able to speak more about that?
 - (a) Have you done any other projects similar to this one?
 4. You've done research on Natura2000, do you feel that it has been successful in protecting lands?
 - (a) What are the problems facing Natura2000 (if any)?
 - (b) What can be done to make Natura2000 more effective?
 5. Do you believe a digital tool of some sort could help combat these biodiversity issues?
 - (a) What would a tool like this target and who would the audience be?
 6. If anything could be changed in Romania tomorrow in regards to the environment what do you think that should be?
 7. Is there anyone else that you think we should try and talk to?
 8. Would you be open to another interview at some point if we have any other specific questions we'd like to ask you?
-

Appendix D: Interview questions for Viorel D. Popescu, Professor at University of Ohio

1. Can you tell us a bit about yourself and your professional experience?
 2. You have done extensive research on the conservation of biology, what would you say are Romania's biggest challenges regarding biodiversity loss?
 3. Can you tell us a little bit about the current Romanian environmental policy?
 - (a) Are there any challenges with implementing environmental policy once it is put in place?
 4. Does the department of climate and sustainability address any issues regarding biodiversity loss and degradation?
 - (a) If so, what are they?
 - (b) What would you say are Romania's biggest concerns regarding biodiversity?
 5. How does climate change impact biodiversity and how can these impacts be decreased?
 6. How Does the department of climate and sustainability work with NGOs in order to further climate objectives?
 7. How can people become more engaged in efforts to promote sustainability?
 8. What are your thoughts on digital based solutions tackling biodiversity loss?
 - (a) What are your thoughts on digital based solutions tackling biodiversity loss?
 9. Can you tell us anything about the issue with carnivores in the Carpathians?
-

Appendix D: Interview questions for Alexandra-Maria Bocșe, State Advisor for Department of Climate and Sustainability

1. Can you tell us about the current bear reporting process in Romania?
 - (a) Is this a similar process in other areas that you've worked?
 - (b) If you're not familiar with the romanian process, can you tell us about what you think would be useful in a reporting process
 2. What kind of data and statistics are most useful when analyzing bear reports?
 - (a) What kind of data would you like to see collected from users?
 - (b) How is data used after receiving a bear report?
 3. Is there information that would specifically be useful to NGOs dealing with Bears?
 4. What do you think of these current questions?
 - (a) Are there more questions that you feel would be useful to collect?
 5. What kind of incidents with bears are occurring?
 - (a) What is the most common bear behavior? (This will help you identify or validate the options in a dropdown selector).
 - (b) Are there any other incidents, not including bears but that could encourage bear incidents happening, such as human behavior (leaving trash out in the street, people feeding bears?) that you'd want to be reported, in order to prevent bear incidents?
-

Appendix D: Interview questions for Gabriele Retez, Researcher at WWF Romania

Appendix E: Digital Tools Table

Idea	Description
Logging Load Size Estimator	Currently the system for taking a picture of truck loads for logging is not very good. Implementing an optical analysis tool of some kind that takes in a number of pictures of a logging load and then estimates the volume of the load would allow for easier tracking of how much wood is being taken away from an area.
Temporary Wetland Identification	There are currently subsidies for leaving areas that hold water for longer periods of time as these temporary wetlands instead of plowing them but there is no way to identify where these areas are. Perhaps by investigating satellite imagery these areas could be identified.
Forest Problem Identification	Currently there are methods of determining what problems crops are facing based on satellite imagery (i.e. underwater, pest problems, etc.). If this could be done using satellite imagery of forests in order to determine what is currently impacting forests (ie bark beetles, climate change, etc.) this could be useful.
Bear Reporting app	Currently reports of bears are made on paper and many of these reports go missing so data is missing on bear issues in some areas of Romania. If an app was created which could systematically gather these reports and then upload them to a database this could help with the loss of information.
Bucharest Green Space Map	Currently there is no good map of all the green spaces in Bucharest, it is not known what is public or private, or what is a nice park and what is a brownfield.
National Parks Ticketing App	National park tickets are purchased in person and with cash (no cards) having an online website/app where tickets could be purchased with cards in advance would be helpful.
National Park Map Application	There is an app for educational purposes that shows good national parks to bring children to, however, this could be expanded so that it could be used by adults as well.

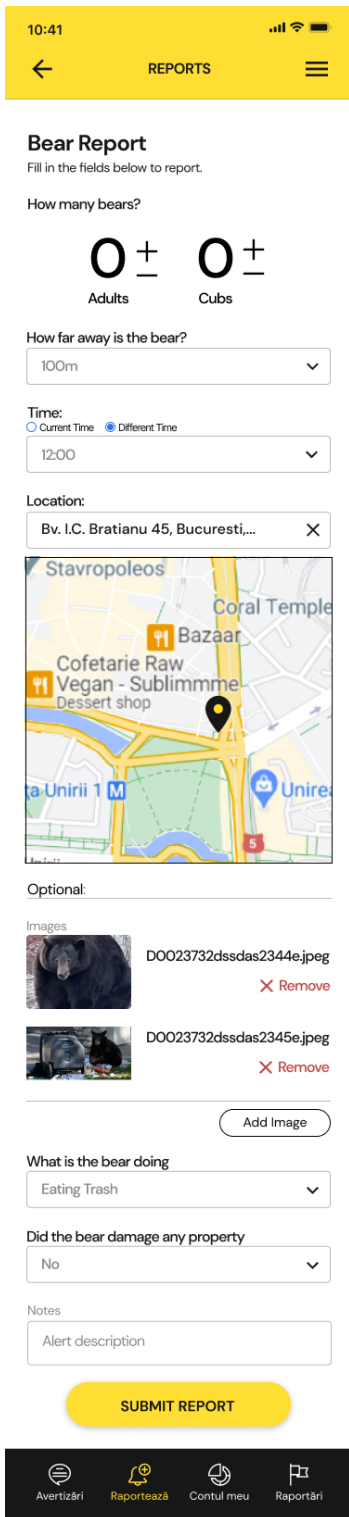
Appendix E: Digital Tool Ideas

Appendix F: Analysis of Digital Tools

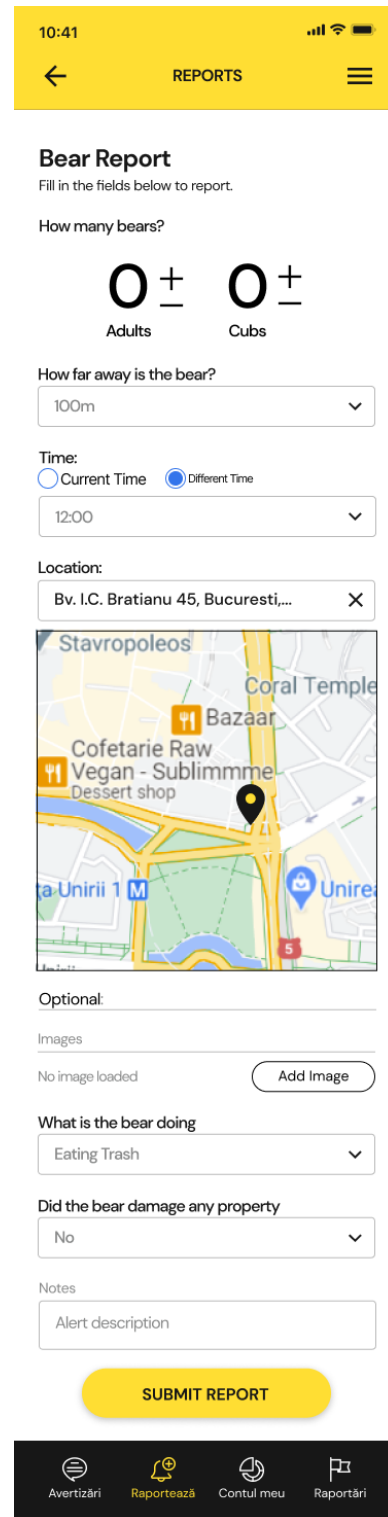
Idea	Clear Audience?	Pressing Issue?	Effective Tool?	Creation Feasible?	Total
Logging Load Size Estimator	3	5	3	1	12
Temporary Wetland Identification	5	3	3	1	12
Forest Problem Identification	4	3	3	1	11
Bear Reporting app	5	4	4	5	18
Bucharest Green Space Map	4	1	2	3	10
National Parks Ticketing App	4	2	3	5	14
National Park Map Application	4	2	3	4	13

Appendix F: Systematic Analysis of Digital Tool Ideas

Appendix G: Figma Screens



(a) Bear Reporting Screen with pictures



(b) Bear Reporting Screen

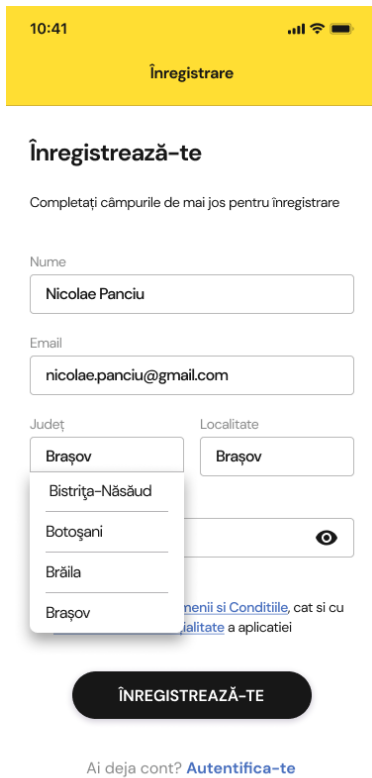
Appendix G: Mockup of reporting flow in figma



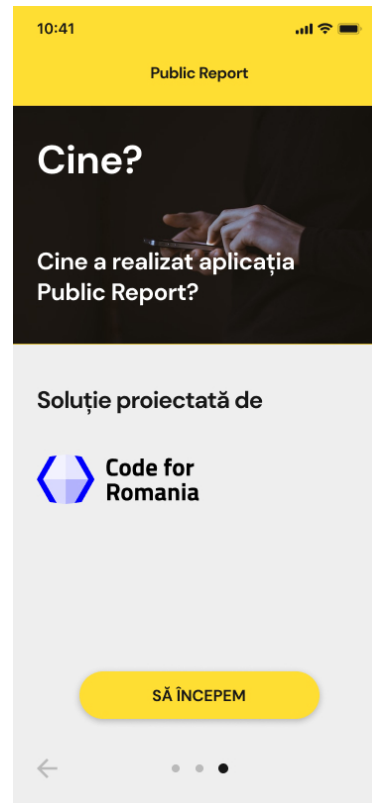
(a) Public Reporter Log In Mockup



(b) Public Reporter Sign up Mockup

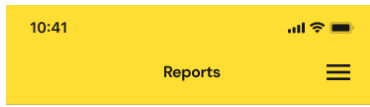


(c) Public Reporter Sign up Mockup



(d) Public Reporter Splash Screen Mockup

Appendix G: Public Reporter sign up flow

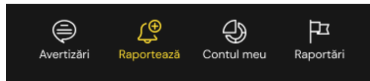


Before you start

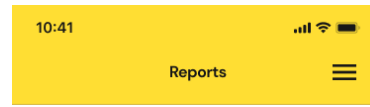
If you or anyone around you is in imminent danger from this bear, stop filling out this form and dial 112 instead.

This is for non-emergency reports only.

CONTINUE



(a) Emergency splash screen before report



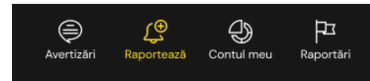
Upload Pictures

Images

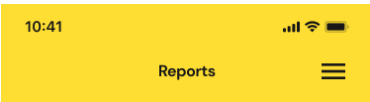
No image loaded

Add Image

RETURN TO REPORT



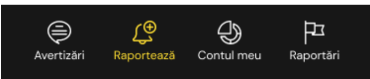
(b) Picture upload mockup



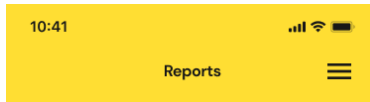
Thank you for the report.

Your notification has been registered with in the system.

You will be notified in the application and by email when the notification status changes.

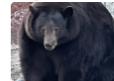


(c) Thank you page



Upload Pictures

Images



DOO23732dssdas2344e.jpeg

Remove

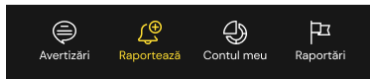


DOO23732dssdas2345e.jpeg

Remove

Add Image

RETURN TO REPORT



(d) Picture Upload Page

Appendix G: Public Reporter report screens

Appendix H: App Fields

Field	Description	Explanation
How Many Bears are there?	How many bears are there? If more than one, are there cubs?	Important to know how many bears there are for tracking purposes - all the other tracking apps also have this, and most specify whether multiple adult bears or bear with cubs
Were there any cubs?	If no, continue, if yes give number	May be good to separate this from the field above
How far away is the bear(s)?	How far is the bear? Probably categorical estimate is better - I.E within 10m, within 100m, within 1km, further than 1km - could be color coded too	It was mentioned in many interviews (WWF, AMB) that people sometimes report bears that are not urgent - i.e. they might see a bear on a hill somewhere and still report it. Therefore, having this information will help filter reports of those types.
Picture(s) of the bear	Optional picture of the bears - maybe video too	Pictures always help and can be used for future analysis, but we don't want to put people in harm's way trying to get a good picture of the bear, and it is not critical for emergency services to know what the bear looks like to respond to a report. A big part of interviews was that it was hard to identify individual bears, pictures help with doing that
Time of sighting	Should default to current time	Selectable time of sighting is important because someone might see a bear but not be able to immediately report it (doesn't have phone on them, no service, etc)
Location	User selectable, but should default to current gps on phone	Location is obviously probably the most important field, without if the emergency services do not know where to go, and bear reports without location are hard to analyze
What is the bear doing	categorical - roaming, in garbage, attracted by people (eg with food), etc, with other field too	Having a categorical estimate of the bear's activities could be important for analysis purposes - I.E. it is a lot easier to get statistical insight into the bears actions with categorical data.
Other notes	Other open ended field for people to write information in	May not be the most helpful but could provide some useful additional information that the above categories do not directly cover.
Did the bear damage any property?	Select all that apply field with items like livestock/buildings/pets	Might be able to be tied into above field (what is the bear doing?), but damage assesment could be important also for estimating severity of bear interaction and response from emergency services. Most other apps we looked at include an analogous field
Did you see any paintball markings?	Asks the user if the bear had any paintball markings on it, and what color they were	Paintballs are sometimes used to track where bears have been, knowledge of any paintball markings would allow authorities to know about where a bear has been

Appendix H: Potential user report app fields

Appendix I: Expert Report Fields

What	Description	Why
Sex of the Bear	Male or female	Bears' aggression levels may vary depending on their gender. Also invaluable information for researchers (data collection).
Where are they being tracked? (area)	The proximity of the bear to civilians	Helps decide whether the bear is an imminent danger.
Were there any tracks left behind?	If so, was it a set of one or more than one?	Helps determine whether there is more than one bear in that area.
Age of the bear?	How old is the bear?	Could be useful for data analysis for researchers.
Recognizable markings on the bear?	If the bear has any distinguishable marks	Will help the expert determine whether the bear is a repeat offender.

Appendix I: Expert Report Fields.