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Species literacy: the perception and cultural portrayal of animals

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The **common moorhen** (Nederlands: **waterhoentje**) is commonly found near freshwater in (sub)urban areas, where it feeds on aquatic plants and creatures.

Chapter 1



General Introduction

At a time when biodiversity is under pressure worldwide and we are at an increasing risk of losing our connection with nature, understanding people's perception of biodiversity has become increasingly important. In particular, people's awareness of animal species deserves our attention, as animals are accessible and effective agents for people to connect with biodiversity. The studies discussed in this dissertation are set in the Netherlands, one of the most densely populated countries in Europe. Through six research projects I have investigated which animals Dutch citizens do or do not know, I have studied cultural sources that may impact children's perceptions of animal diversity, and, from the perspective of biodiversity communicators, I have explored the potential to connect people with biodiversity in places that are becoming increasingly urbanized. Moreover, I introduce and discuss a new concept that highlights species as an accessible way to learn about biodiversity: species literacy. The research discussed in this thesis can be regarded as a step towards broadening people's perception of animal diversity, which can ultimately help expand the role of biodiversity in people's lives.



1.1 Values associated with animal biodiversity

Our world is home to an astounding diversity of animals. The animal kingdom comprises all shapes and sizes, from tiny pseudoscorpions that jump aboard large beetles for public transport, to giants like blue whales: the largest animals known to have ever existed. Animals display a multitude of different behaviors and they are present almost everywhere, from remote islands, rainforests, and deserts, to suburbs and city centers, and even on our bodies: unknowingly, most people offer a place of residence to microscopic follicle mites.

Animals play a significant part in our lives, whether we are aware of it or not. First, they hold an important ecological value. Worldwide, animals facilitate ecological processes such as biomass production, decomposition, and recycling (Danovaro et al., 2008; Hättenschwiler & Gasser, 2005), and provide ecosystem services such as pollination, seed dispersal, and waste removal (Ćirović et al., 2016; DeVault et al., 2003; Wenny et al., 2011; Winfree et al., 2018). Diverse communities in particular can aid in the persistence of resources and essential actions provided by ecosystems when conditions change (Boulton et al., 2008; National Research Council, 1999). For instance, a greater diversity of fish enhances reef fish biomass and buffers global fish biomass against the effects of climate change (Duffy et al., 2016). In line with this, biodiversity has been highlighted as an indicator for sustainable development (Blicharska et al., 2019; Niesenbaum, 2019; Schultz et al., 2016).

Secondly, although monetizing the natural world is problematic (Admiraal, 2016; Novacek, 2008), animals unquestionably hold an economic value. Animals are regarded as natural capital and contribute substantially to economies (National Research Council, 1999). Industries depend on animals for the production or development of goods and commodities such as food, biochemicals, and fuel, and sectors like (eco)tourism and hunting depend largely on animals as well (Curtin, 2009; National Research Council, 1999; Spalding et al., 2017). The animal kingdom also represents an inexhaustible source of inspiration for people that work in the arts, the entertainment business, and the fashion industry. Some of the best known and popular characters in films and animations are animals (Fukano et al., 2020; Yong et al., 2011), and images of animals are frequently incorporated in the design of commercial products that range from clothes to wall paper. Furthermore, animals are regularly featured in marketing and advertising strategies to help promote products or services (Berland, 2019; Burton & Collins,

2015; Feldhamer et al., 2002; Lerner & Kalof, 1999), and the large variety of species offers healthcare and pharmaceutical industries potential for new discoveries and for the development of new applications and products. For example, the market value of undiscovered anti-cancer drugs originating from marine organisms like sponges and mollusks was estimated to be between 563 billion and 5.69 trillion American dollars (Erwin et al., 2010).

Finally, and most importantly in relation to the theme of this thesis, people attach personal values to animals. Since the dawn of humankind animals have captivated us and have played important roles in human culture. Rock paintings of animals in the Caves of Lascaux and animal motifs on Egyptian mummies mirror the central role that animals played in ancient cultures (Herzog & Galvin, 1992; Hill, 2021). To this very day, animals are part of people's cultural identity and heritage (K. M. A. Chan et al., 2012), and may act as significant symbols in human society (Hill, 2021; Lerner & Kalof, 1999).

Animal biodiversity provides people with countless opportunities for educational, aesthetic, spiritual, or otherwise enriching experiences and activities. People may enjoy animals during leisure activities outdoors such as birding or they may marvel at the diversity of life through exposure to animals via cultural sources such as nature films, experiences that can kindle feelings of wonder and awe. Animals can also contribute to a *sense of place and belonging*: a grounded feeling that is associated with recognizing certain features of their environment, including the animals that reside there (Horwitz et al., 2001; Reid et al., 2005; Standish et al., 2013).

Research has demonstrated that people appreciate species richness and attach aesthetic values to biodiversity (Dallimer et al., 2013; Hedblom et al., 2014; Lindemann-Matthies et al., 2010; Southon et al., 2017). People may even value animals that they have had no direct experience with themselves (Mace et al., 2012), e.g. by taking pleasure in knowing that species such as tigers, elephants, and polar bears, exist, or by feeling satisfied when biodiversity is preserved for future generations (Novacek, 2008). It seems that exposure to biodiverse environments in particular contributes to people's psychological well-being (Clark et al., 2014; Curtin, 2009; Fuller et al., 2007; Luck et al., 2011; Sandifer et al., 2015). For instance, research suggests that people derive further pleasure when they watch a larger variety of birds (Cox & Gaston, 2015), and that exposure to a greater diversity of fish in an aquarium exhibit has greater calming effects (Cracknell et al., 2016).



1.2 Threats to animal biodiversity

Despite the values that it provides to people, animal biodiversity currently faces significant threats at both local and global scales; threats that are all caused by human needs and desires (Moss et al., 2017). The human population on our planet has grown to 7.9 billion and is projected to increase by almost one-third to around 10 billion in 2050 (Worldometers.info, 2021b). This brings with it large-scale modification of the environment. For instance, cities and towns are expanding rapidly, humans are extracting large amounts of water, timber, and other resources from the environment, and over half of all land surface is currently used for livestock or agriculture (H. Mooney et al., 2009). In addition to these land modifications, biodiversity is threatened by habitat destruction, overexploitation, pollution, invasive alien species, and climate change (European Commission, 2015). Together, these threats pose formidable challenges to the conservation of animal biodiversity.

While the impact of humans on the environment continues to take place, biodiversity continues to be lost rapidly, at a rate unprecedented in human history (De Vos et al., 2014; Díaz et al., 2019; Pimm et al., 2014). Extrapolations suggest that we are faced with an extinction crisis of the same magnitude as the end-Cretaceous extinction, when over 75% of existing species were lost, including non-bird dinosaurs (Palombo, 2021). Further imminent extinctions are indicated by the declining populations of many species. The most recent Living Planet Index showed that between 1970 and 2016 vertebrate populations suffered an average 68% decline (WWF, 2020). For instance, populations of iconic animals such as lions (Riggio et al., 2013), elephants (Chase et al., 2016), sharks (Pacoureau et al., 2021), cheetahs (Durant et al., 2017), and birds of prey (McClure et al., 2018) have plummeted in recent years. Moreover, steep population declines have been reported for invertebrates, such as terrestrial arthropods (Sánchez-Bayo & Wyckhuys, 2019; Seibold et al., 2019).

Especially in highly urbanized and industrialized parts of the world, pressure on biodiversity has been and still is significant. In Europe mammals such as bears and wisent were lost from areas inhabited by large numbers of humans (Chapron et al., 2014; Deinet et al., 2013) and a 17-19% decline in avifauna has been estimated since 1980: a loss of 560–620 million individual birds (Burns et al., 2021). For instance, house sparrows and starlings have disappeared at an alarming rate. In the Netherlands, the population of black-tailed godwits, the country's National

bird, has declined by 70 percent since the 1970's (Kentie et al., 2016).

Authors have referred to the ongoing loss of fauna as *defaunation* (Dirzo et al., 2014; Young et al., 2016) and *biological annihilation* (Ceballos et al., 2017). Currently, of over 80,000 animal species that have been assessed worldwide, nearly 16,000 species are listed as threatened according to the IUCN Red List criteria, meaning that these species are vulnerable, endangered or even critically endangered (IUCN, 2021).

1.3 The need for broad-based support

The ongoing decline in biodiversity is an urgent environmental issue that demands attention. In 2011 the United Nations declared 2011-2020 as the 'Decade on Biodiversity' and issued a framework for action to save biodiversity. To help avert further loss, broad-based support from society is vital, because conservation depends on the general public for funding and because a widely shared willingness of the general public to conserve biodiversity can encourage decision makers to implement policies. It is unlikely that governments or industries will change course when there is a lack of public concern about biodiversity (CBD, 2013; Novacek, 2008).

However, raising support for conservation is challenging these days. There are opposing interests at play (e.g. economic and ecological), and messages about biodiversity can be overshadowed by messages about other matters, including other environmental subjects. For instance, Novacek (2008) has stated that there has been a shift in attention to global warming and climate change away from issues such as biodiversity loss. The depressing nature of the continuing loss of biodiversity may further pose a barrier towards engagement, as people might get the idea that any efforts to conserve biodiversity will fail (Balmford & Cowling, 2006). People may feel hopeless or helpless (Allen, 2013; Moreno-Tarín et al., 2021) and may get the impression that money and effort invested in conservation is spent in vain (Miller, 2005). Finally, a big challenge is that simultaneously with the loss of biodiversity, there appears to be a widening gap between people and nature (Miller, 2005).



1.4 An extinction of experience

Throughout history, humans have shared an intimate relationship with the natural world, depending directly on their immediate surroundings for anything from food to shelter (Keniger et al., 2013). In contrast, most people nowadays are much less reliant on direct interaction with nature. More people than ever before are living in urban and suburban areas. While a mere 3% of the earth surface is taken up by cities, over half of the world's population resides there and the fraction of people living in cities will keep on growing in the following decades (United Nations, 2014; Wu, 2010). These changes have modified the ways in which people interact with biodiversity in their daily lives (Pett et al., 2016).

First, there seem to be reduced opportunities to experience nature directly. Many citizens live in neighborhoods where green space is sparse, access to wild habitats for outdoor activities is restricted, and biodiversity is impoverished (Cox et al., 2017; Miller, 2005; Turner et al., 2004). Reports show schools devote less time on fieldwork than before (Cheesman & Key, Roger, 2007; Scott et al., 2012, 2015), and there are indications that living organisms are used less frequently in classrooms (Barker & Slingsby, 1998; Reiss & Beaney, 1992), reducing opportunities for children to experience the natural world firsthand.

Secondly, people's orientation towards engaging with nature seems to be changing (Soga et al., 2018; Soga & Gaston, 2016). For instance, people nowadays tend to be less inclined to spend time on nature-based recreation (Pergams & Zaradic, 2006, 2008; Soga & Gaston, 2016), and an increasing number of children seem more drawn to indoor activities like gaming than to playing outside (Kimbell et al., 2009; Lucassen et al., 2020; Van den Boorn, 2007). Parents living in increasingly urbanized settings with lots of traffic may further be concerned about letting their children explore the outdoors (Malone, 2007).

As a result of these changes, people seem to have become isolated from experiences with biodiversity. There seems to be an *extinction of experience* (Pyle, 2011). Research suggests that compared to past generations children engage less with nature outdoors (Soga & Gaston, 2016). Langers (2018) reported that in the Netherlands primary school children's visits to forests, agricultural areas, and nature reserves declined between 2006 and 2015. Such restricted interaction with nature is likely to last into adulthood. Research findings show that adults who were exposed less frequently to nature during childhood visited green areas less (Hinds & Sparks, 2008; C. W. Thompson et al., 2008).

The gradual separation between people and nature also seems to manifest itself in cultural expressions, which suggests that opportunities to experience nature indirectly are also changing (Mccallum & Bury, 2013; Williams et al., 2012). References to nature have decreased since the 1950s in fiction books, song lyrics, and film storylines (Kesebir & Kesebir, 2017), and Disney films have become increasingly poor in species (Prévot-Julliard et al., 2015). When a new edition of the Oxford Junior Dictionary was published 2007, it had deleted animal names like adder, kingfisher, and otter, while words such as blog, chatroom, and cut-and-paste had been added (Macfarlane, 2015).

1.5 Potential impact on people's perception of biodiversity

The widening gap between people and nature is a big challenge for conservationists. Not only may billions of people lose opportunities to benefit from nature (Louv, 2005), the separation from nature could also diminish people's opportunities to become familiar with and connect with biodiversity (Turner et al., 2004). This could negatively affect conservation, as people tend to care about what they know (Balmford et al., 2002) and may not feel equipped to make informed decisions related to a subject that they are not knowledgeable about.

There are indeed indications that a growing distance between people and nature is affecting people's perceptions. For instance, it appears that nature vocabulary has been lost from societal and daily conversation (Barnett, 2019; Macfarlane, 2016, 2017; Morris & Macfarlane, 2017; Stibbe, 2012, 2014). Pilgrim et al. (2008) found that ecological knowledge was lower in communities independent of the local environment for subsistence, and Kai et al. (2014) concluded that in local communities in China, biodiversity decline was associated with a loss of ecological knowledge. This links to the *shifting baseline syndrome*, which can occur when people unaware of past conditions get used to baselines of lower biological and environmental quality and diversity (Kellert, 2002; Papworth et al., 2009; Pauly, 1995), and which may mute people's sense of urgency. The findings by Kai et al. (2014) also exemplify the process of *generational amnesia*, as older people were better skilled at identifying animals than young people (Kahn, 2002; Papworth et al., 2009).

Overall, it seems that nowadays laypeople's perception of biodiversity is narrow. People tend to struggle with accurately estimating species richness



(Dallimer et al., 2012; Lindemann-Matthies & Bose, 2008; Pett et al., 2016; Schwartz et al., 2014), which suggests that people have poor identification skills. In line with this, concern has been raised that people's knowledge about common, native species in particular is restricted (Balmford et al., 2002; Huxham et al., 2006). In this dissertation, we call this limited knowledge about species a lack of *species literacy*. Apart from restrictions in the number of species that people know, there are signs that laypeople's perception is biased towards domestic and exotic species (Ballouard et al., 2011; Genovart et al., 2013; Lindemann-Matthies, 2005). Such a skewed perception of biodiversity may result from reduced opportunities to experience nature directly, but may also stem from indirect experiences with animals, when people are exposed to cultural representations of the natural world.

1.6 Cultural representations

Despite the growing distance between humans and nature in modern society, people remain exposed to cultural representations of the natural world, in particular portrayals of animals. Animals are regularly featured in the media, fashion, and design, and they are frequently represented as toys, mascots, and tattoos. Together, such portrayals reflect how society perceives and appropriates animals, but they also provide unprecedented access to biodiversity (Kellert, 2002). For instance, people may readily come across portrayals of species that are found only in small numbers in the wild or that are seldom seen outdoors due to their reclusive lifestyles (Berland, 2019; Courchamp et al., 2018). Representations of animals reach very large audiences, including groups that lack time and interest to actively educate themselves about biodiversity (Small, 2016). This raises the interesting question if portrayal of animals compensates for the loss of direct experience with nature.

Repeated exposure to images of animals, even when this exposure is subtle and accidental rather than purposefully organized for educational purposes, impacts people's perceptions (Bornstein & D'Agostino, 1992; Burton & Collins, 2015; Kaikati & Kaikati, 2004; Kalof et al., 2015; Roy & Chattopadhyay, 2010; Zajonc, 1968). Past research has demonstrated that cultural representations of animals shape people's awareness of species; e.g. portrayals may influence what species people know (Alves et al., 2014; Ballouard et al., 2011; Dixon et al., 2005).

Exposure to animal portrayals may further trigger interest and engagement, and can help build positive attitudes towards animals (Kalof et al., 2015; Pearson et al., 2011). It was found that the animated films *Madagascar*, *Finding Dory*, and *Rio*, and the nature film *Planet Earth*, led to substantial increases in online searches for animals featured in these movies (Fernández-Bellon & Kane, 2019; Silk et al., 2018). Similarly, Fukano et al. (2020) demonstrated that the Japanese animated television program *Kemono Friends* promoted public interest in threatened animals; the TV show even led to increased donations for conservation.

However, portrayals of animals will not necessarily help people with developing a broad and balanced view on biodiversity. First, cultural sources may represent only part of the animal kingdom; e.g. nature film makers have been accused of mainly portraying charismatic megafauna from overseas (Ballouard et al., 2011). Such biases may lead people to adopt a narrow and biased perception of animal diversity (Celis-Diez et al., 2016). Secondly, the way in which animals are portrayed may detract from the learning potential of cultural sources. Portrayals may be unspecified (e.g. when a prototypical butterfly is displayed instead of a peacock butterfly), which will not help expand people's perception of different species. Similarly, distorted and artistic depictions of species that therefore are hardly recognizable and unspecific references to species (e.g. when a mallard is referred to as 'duck') will make it hard for people to search for information about specific species and learn more about them (Fernández-Bellon & Kane, 2019). Research has demonstrated that young children are less likely to link cultural references to real objects when the perceptual similarity is lower (Ganea et al., 2008). When animals are portrayed in an anthropomorphized fashion, this may not only obscure the link with the species that they represent, but this may also induce misconceptions about their natural behavior (Ganea et al., 2014; Geerdts, Van De Walle, et al., 2016; Waxman et al., 2014).

As urbanization continues, cultural representations of animals will play an increasing part in shaping people's perception of biodiversity (Gerbner, 1969; Kellert, 2002; Kesebir & Kesebir, 2017; Potter, 2014; Prévot-Julliard et al., 2015; Soga, Gaston, Yamaura, et al., 2016). This makes it important to understand what image of animal biodiversity cultural sources present to the public, especially products targeted at children, as childhood is considered to be a critical period for developing a lasting connection with the natural world.



1.7 The importance of biodiversity communication

While cultural sources usually provide subtle exposure to animal biodiversity, people who communicate biodiversity to lay audiences could offer a more direct route to connect people with biodiversity. In line with this, international agendas feature communication as a good starting point towards raising biodiversity awareness and broad-based support for conservation (CBD, 2013). Communicators can promote broader awareness and deeper understanding of the diversity of life, which can help people make choices and well-informed decisions. For example, people will only be able to make a weighted judgement about the importance of halting biodiversity loss, when they are aware of biodiversity in the first place. Becoming aware of local flora and fauna may further help people living in highly urbanized settings realize that biodiversity is relevant for them, too.

However, communicating biodiversity can be challenging, as people vary widely in their knowledge base and attitudes, and this diversity affects outcomes (J. H. Falk & Adelman, 2003; Scheufele, 2018). Laypeople can differ considerably from professionals in their understanding, expectations, and the language they use, potentially hampering communication (Bullock et al., 2019; Venhuizen et al., 2019). For instance, one significant challenge in biodiversity communication constitutes the concept of biodiversity itself. Since its inception by Walter Rosen of the National Research Council in 1986 (Sarkar, 2002), the term biodiversity is most commonly used by biologists, environmentalists and conservationists worldwide (Elder et al., 1998). For laypeople the concept remains quite abstract, and its technical and multidimensional character makes the concept difficult to understand (Novacek, 2008; Wals & Weelie, 1997). In fact, many people do not recognize and comprehend the term (Fischer & Young, 2007; Lindemann-Matthies & Bose, 2008; Moss et al., 2014; Turner-Erfort, 1997). A survey showed that in 2015 only 59% of Dutch lay respondents had heard of the concept of biodiversity and a mere 27% could correctly define it, suggesting that messages about biodiversity may currently not be understood by society at large (European Commission, 2013; UEFT, 2018).

Although it may be strategic for communicators to use simpler alternatives such as species to represent biodiversity and communicate it in an accessible way, challenges in communication may present themselves here as well. As mentioned before, there are indications that laypeople lack knowledge about species, i.e. that their level of species literacy is low. This can impact their response

to messages too. A picture of a nonvenomous snake species at an entrance board of a nature trail may scare people who misidentify it as a venomous species, and species names that people are unfamiliar with may act as jargon. This illustrates that it is valuable for communicators to be aware of knowledge levels within their target groups, and to have a clear picture of the knowledge level that they strive for in their audiences. For example, being aware of current levels of species literacy would enable communicators to connect to people's existing understandings and could provide clarity about steps needed to expand people's perception of biodiversity.

1.8 The Netherlands: An urbanized country as a test-case

As biodiversity loss continues and people are at an increasing risk of losing touch with nature, it is increasingly important to understand people's perception of animal biodiversity and to explore current practices in biodiversity communication. This may ultimately help expand the role of biodiversity in laypeople's lives. As more and more people grow up in industrialized and urbanized environments, and global conservation will increasingly depend on the ability of urbanites to maintain a connection with nature, it is especially important to study people's perceptions in areas that have become or are becoming increasingly urbanized.

The studies comprised in this thesis are all set in in the small and densely populated Netherlands (national population of 17.6 million people; 522 people/km² (CBS, 2021) where over 90% of the population is urban (Worldometers.info, 2021a). As such, the country can serve as a model and test-case for assessing the connection (or lack thereof) between people and nature in a rapidly urbanizing world. In this dissertation we use species literacy as a *pars pro toto* to study biodiversity awareness. In addition to establishing current levels of species literacy and factors that drive these levels, the thesis aims to explore species literacy levels in laypeople as estimated and desired by biodiversity communicators, and to find out what picture of animal biodiversity is portrayed by cultural sources targeted at children. Finally, this thesis aims to determine opportunities for and challenges to expand the role of biodiversity in laypeople's lives. Based on these research goals, the following research questions arise:



Part I: Species literacy

- 1) What is the level of species literacy in Dutch laypeople? (Chapters 2 + 3)
- 2) What are drivers for species literacy in Dutch laypeople? (Chapter 2)
- 3) To what extent are two important components of species literacy – species identification and in-depth species knowledge – associated with each other? (Chapter 3)

Part II: Cultural sources

- 4) Which taxa and types of animals (exotic or native, and domestic or non-domestic) are portrayed as cultural representations targeted at children? (Chapters 4 + 5)
- 5) To what extent are animals in cultural representations targeted at children specified or anthropomorphized? (Chapters 4 + 5)

Part III: Perspective from communicators

- 6) How do biodiversity communicators perceive the current role of biodiversity, including the current level of species literacy, in Dutch laypeople? (Chapters 6 + 7)
- 7) What importance do biodiversity communicators place on species literacy in laypeople and what is the desired level? (Chapters 6 + 7)
- 8) What potential do biodiversity communicators see in the Netherlands for expanding the role of biodiversity in laypeople's lives? (Chapter 7)

1.9 Outline

This thesis comprises eight chapters: a general introduction, six empirical research chapters based on studies situated in the Netherlands, and finally a general discussion.

Part I: Species literacy

The first part of this dissertation focuses on the current perception of animal biodiversity, by introducing and exploring the new concept of species literacy. It explains what species literacy is, and explores the different dimensions of species literacy: which components it comprises and how they are interconnected.

Chapter 2 elaborates on the concept of species literacy and describes why it can be valuable for people to be knowledgeable about species. Furthermore this

chapter reports the findings of a quantitative research project that established the level of species literacy in biodiversity professionals, primary school children, and the general public, using an animal species identification test. Insight is provided into biodiversity awareness, and information is obtained about the possible connection or lack thereof between Dutch citizens and the natural world. In addition, possible determinants for species literacy are explored, using correlation and regression analyses. Implications of these findings for conservation and communication are discussed.

Chapter 3 investigates whether species literacy can be accurately measured via species identification tests, i.e. if species identification skills are suitable indicators for in-depth knowledge about species. This is valuable information for researchers and communicators who may wish to use identification tests to assess knowledge levels in their target groups. To this purpose, an animal knowledge test was distributed among a large sample of online participants. The chapter shows to what extent accurate species identifications predict knowledge about the origin of species, their habitat, diet, and behavior, and reveals knowledge gaps and misconceptions about animals in Dutch adults. Reflecting on the findings, the value of species identification tests is discussed.

Part II: Cultural sources

The second part of the dissertation zooms in on cultural representations of animals, as they may reflect and affect people's perception of animal biodiversity. This section is based on two separate research projects that used quantitative content analyses to explore the image of animal biodiversity that is conveyed by two product categories made for young children. Chapter 4 reports the findings of a study on representations of animals in children's clothes, while Chapter 5 discusses the portrayal of animal biodiversity in children's picture books. Coding a sample of around 800 animals portrayed on clothes, and over 2,000 animals depicted in picture books, we report what taxa and types of animals are represented, how they are portrayed, furthering our understanding of how animal biodiversity is currently appropriated by the fashion and entertainment industry. Moreover, we note and discuss opportunities to specify and diversify the portrayal of animal biodiversity in picture books and clothing.



Part III: Perspective of communicators

The third part of this thesis explores opportunities and barriers in expanding people's perception of biodiversity. It focuses on the perspective of Dutch biodiversity communicators. As more and more people grow up in an urban environment, it is important to find out if urban environments offer sufficient opportunities for human-nature interaction to unfold, and what role communicators can play.

Based on the idea that it is important for communicators to know their target audience, Chapter 6 presents findings of a quantitative study that investigated whether biodiversity communicators are aware of the average level of species literacy in primary school children, and if and why they think knowledge about species is important. Moreover, the chapter reports what level of species literacy communicators deem desirable in children, which ultimately can help set educational goals. The value of assessments to bridge the gap between expected and actual knowledge levels in target audiences is discussed.

Chapter 7 presents the results of a qualitative research project with biodiversity professionals that explored motivations, opportunities and challenges to expand the role of biodiversity in people's lives in an increasingly urban world. Semi-structured interviews were carried out with 12 professionals, and their perception and experience were analyzed. The chapter reflects on possible routes to connect people to biodiversity, and provides an overview of best practices that professionals operating in urban contexts could use to reach out to their respective audiences regarding biodiversity. As such, the findings described in this chapter may empower and encourage professionals in urbanizing parts of the world who communicate about biodiversity, and may ultimately help grow biodiversity awareness and broad-based support for conservation.

Part IV: Reflection and future directions

Chapter 8, the final part of the dissertation, reflects on the work presented here in this thesis and makes connections to relevant literature. Major outcomes of the research are highlighted and put into perspective. A framework for species literacy is presented, and promising avenues for raising species literacy and connecting people to biodiversity are distilled. Additionally, directions for further research are provided, as interesting opportunities exist for future studies on species literacy.