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Species literacy: the perception and cultural portrayal of animals

Hooykaas, M.J.D.

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Part IV:

Reflection and Future Directions



The **kingfisher** (Nederlands: **ijsvogel**) is a territorial bird species specialized in catching fish. Its nest is often found in a burrow excavated in a river bank.

Chapter 8

Discussion

This thesis provides insight into people's perception of animal biodiversity. This is valuable from a scientific perspective, and it is also important in the context of conservation, as biodiversity is currently declining rapidly and the relationship between humans and nature is under increasing pressure. The six studies presented in this dissertation were all set in the Netherlands. As a densely populated country, the Netherlands constitutes a good model to assess (dis)connections between people and nature in a world that is increasingly urbanized.

In this final part of my thesis I will highlight the main findings of my research, and I will point out how the findings connect to each other. Moreover, I will give an overview of important implications of the findings and corresponding recommendations for conservationists and communicators. Finally, I will note directions for further research, emphasizing the value of continued efforts to study people's perceptions of biodiversity.

8.1 Species literacy in the Netherlands

8.1.1 Levels of species literacy in laypeople and professionals

In the first part of this thesis I have explored levels of species literacy in the Netherlands, as a *pars pro toto* to study biodiversity awareness.

Chapter 2 explained the new concept species literacy, which consists of two main components: broad knowledge about species, which involves knowledge of basic characteristics and names of species that enable a person to distinguish and identify species, and in-depth knowledge about species, which involves background information about species, e.g. where and how they live. Moreover, Chapter 2 discussed a quantitative research project that used a species identification test comprising native animal species to assess the levels of species literacy in primary school children and the general public. The species literacy level of biodiversity professionals was also determined, which put into perspective laypeople's perceptions. **Chapter 3** presented results of an animal knowledge test among a large sample of adult participants, which tested their species identification skills and in-depth knowledge about species, and included both native and exotic animals.

Whereas species literacy was high among professionals, laypeople's perception of animals turned out to be meager. Professionals performed better both at identifying animal species and answering in-depth knowledge questions about their origin, habitat, diet, or behavior. As shown in Chapter 2, species literacy was especially low in primary school children, who on average identified only one in three native animal species.

Laypeople knew only a specific fraction of animal biodiversity. In particular, people were well informed about mammals, which was in line with previous findings in other countries (Huxham et al., 2006; Lindemann-Matthies, 2005; Patrick et al., 2013). As mammals that received high identification rates such as foxes and hedgehogs are rarely encountered outdoors due to their reclusive way of life, direct exposure to animals in the wild clearly is no prerequisite for becoming familiar with animals, although it cannot be ruled out that rare encounters leave particularly large and lasting impressions. A more likely explanation for people's familiarity with mammals is their frequent portrayal in human culture, as discussed in Chapters 4 and 5. This is in line with the test results presented in Chapter 3, where exotic animals that are regularly displayed in cultural products



and the media (e.g. giant panda), were well-known not only by professionals but by lay participants as well.

The poor ability to identify native birds and butterflies was striking, especially in primary school children. Over 80% of the children failed to identify common bird species such as the house sparrow, blackbird, and jackdaw. As these species prevail in densely populated areas in the Netherlands, their low identification rates are unlikely to stem from a lack of opportunity to experience them directly. More likely reduced engagement with the outdoors, little time spent in and on the local environment (e.g. during (non-)formal education), and possibly a lack of interest in native animals, prevents people from familiarizing themselves with these animals.

In addition to a restricted range of animals, laypeople's understanding of animal species was shallow, evidenced by limited specificity of respondents' answers and misconceptions about animals' way of life. Answers to the identification test discussed in Chapter 2 were frequently provided at superordinate levels (e.g. the red admiral butterfly was often named 'butterfly', the 'chaffinch' often referred to as 'bird'). Furthermore, as reported in Chapter 3, people were more likely to correctly identify species than to exhibit in-depth knowledge about them. Misconceptions were uncovered about species' origin, habitat, diet, and behavior, some of which seemed to be caused by extrapolation of traits from species' relatives that people may know from zoos or from portrayals in the media (e.g. wrong assumptions that all penguins live in polar regions). It appears that names and physical characteristics often serve as a starting point when people get to know species, and that understanding may remain fragmentary if this is not accompanied or followed up by in-depth information about the animals' way of life.

8.1.2 Drivers of species literacy

Apart from current levels of species literacy, Chapter 2 has discussed possible determinants of species literacy. Correlation and regression analyses on data from the species identification test revealed factors associated with species identification skills and suggested pathways that foster knowledge about species.

I found indications that both direct and indirect experiences with biodiversity drive species literacy in laypeople. Participants with a garden identified a greater number of animals than those without a garden, which suggests that people become aware of native species when observing wildlife close to their homes, in

line with the idea that bird feeding can connect people to nature (Cox & Gaston, 2015, 2016). Species literacy was also associated with media exposure, yet it only was a significant contributor in the model for the general public, not in the model for children 9/10 years old. The question arises whether there may be fewer opportunities for Dutch children than for adults to learn about local biodiversity through the media, e.g. due to a stronger focus on foreign nature in media aimed at children.

I further found support for the idea that when people become familiar with species, they develop a raised interest and affinity towards them (Palmberg et al., 2015; Schlegel & Rupf, 2010). People's identification skills correlated positively with laypeople's attitudes towards nature and animals. However, it is important to note that the direction of the interaction could not be determined. Positive attitudes towards animals can trigger people to search for information about species, so that they become more knowledgeable. Most likely an interplay exists between knowledge, interest, and affinity.

Finally, associations were established between species literacy and demographic variables. Species literacy increased with age, which seems to suggest that Dutch citizens develop knowledge about species over the course of their lives, yet it should be noted that this pattern is also in line with the process of generational amnesia, whereby knowledge about the environment is lost over generations, e.g. because of reduced experience of biodiversity (Kahn, 2002; Papworth et al., 2009). Furthermore, species literacy increased with educational level, suggesting that people derive part of their knowledge about species during formal education. Lastly, although in the general public population, male participants achieved slightly higher scores than females, in children gender did not seem to modulate the relationship with local fauna.

8.1.3 The association between species identification and in-depth knowledge

The research project discussed in Chapter 2 used participants' ability to identify species presented to them as photographs to determine species literacy levels, similar in approach to a large number of previous studies that have used species identification tests not only to determine which species people can identify, but also to measure what people know about species or nature overall. However, it was actually not yet known to what extent species identification is a reliable



indicator for in-depth knowledge about species. To fill this important gap in the literature, I investigated the presumed association between these two important components of species literacy.

As described in Chapter 3, species identification turned out to be a reasonably good indicator for in-depth knowledge about species, and a far better predictor than alternative variables such as age and gender. The odds for having in-depth knowledge about the origin of species, their habitat, diet, or behavior were considerably higher for those who correctly identified species as compared with those who did not correctly identify species. The findings suggest that as people develop species identification skills, this triggers them to learn more about the way of life of species too (Barker & Slingsby, 1998; Leather & Quicke, 2009). Moreover, people may use their in-depth knowledge to identify species, strengthening the association between the two knowledge components. All in all, we can conclude that species identification tests are suitable tools for professionals to determine levels of species literacy.

8.2 Cultural representations of animals

In the second part of this thesis I have examined the portrayal of animals in cultural products aimed at children. These cultural representations are likely to both reflect and impact people's perceptions of animal biodiversity. **Chapter 4** presented the findings of a project where a sample of over 800 animals portrayed in children's fashion was coded, while **Chapter 5** discussed the analysis of a sample of over 2,000 animals depicted in children's picture books. Studying the taxa and types of animals portrayed in these two product categories and the way in which they were represented, I explored how the animal kingdom is currently appropriated by fashion designers and picture book makers.

Despite the different nature of fashion and literature, I uncovered transcending patterns through my analysis. Children's clothes and picture books both featured animals frequently, yet of limited diversity. Strong biases were found. Vertebrates outnumbered invertebrates, in line with cultural sources such as postage stamps (Nemésio et al., 2013), nature magazines (Clucas et al., 2008), and Instagram (Heathcote, 2021). Insects were restricted largely to butterflies in girls' fashion, and to elements of scenery in picture books. Still, within vertebrates there was variation too. Notably, mammals were numerous and depicted prominently. In

picture book stories they regularly served as protagonists, while animals such as birds and fish were portrayed more subtly and less frequently, despite being more abundant and species rich in the outside world. Additionally, exotic and domestic animals were prevalent, a pattern that has been found previously for other cultural sources as well (Ballouard et al., 2011; Burton & Collins, 2015; Celis-Diez et al., 2016; Sousa et al., 2017). Finally, in children's fashion some animals were restricted to either boys' or girls' clothing; e.g. dinosaurs were only encountered on clothes marketed at boys.

Only a minority of the animals could be identified at the species level. Animals were depicted in various artistic styles and often their portrayals were abstracted and transformed, which reduced their recognizability. Many animals were anthropomorphized, as they were depicted as wearing clothes, having human facial expressions, and/or behaving as humans. On clothes marketed at girls, animals were often cute-ified and feminized. In picture books, text references to animals were often missing, and when animals were mentioned, they were often named above the species level, even in cases when distinct species had been depicted. Interestingly, specificity of the portrayals differed between taxonomic groups, as mammals were depicted and named at the species level more frequently than other animals.

The limited range of animals featured in childrenswear and picture books may flow from a poor understanding of animal diversity in designers, illustrators, and authors. After all, these creatives can only portray animals that they are aware of. However, representations of animals in cultural products may also be understood from a strategic and commercial point of view. It seems that cultural product makers depict animals that are likely to resonate well with the public. For instance, people tend to appreciate the appearance of mammals (Macdonald et al., 2015; Smith et al., 2012) while they dislike invertebrates for their dissimilarity to humans (Batt, 2009). Such predispositions may explain why mammals are generally overrepresented in cultural products and why invertebrates are underrepresented as compared to their actual diversity and abundance. Creatives also seem to strategically tap into people's affinity for domestic animals and their attraction to exotic megafauna (Lindemann-Matthies, 2005). It was striking that books from Dutch publishers portrayed as few species native to the Netherlands as books from foreign publishers.

A commercial standpoint also helps to explain the way in which animals



are portrayed in cultural products. Picture book makers and fashion designers probably anthropomorphize, cute-ify, and artistically transform animals to make them appealing and easy to relate to (A. A. Y.-H. Chan, 2012; Marriott, 2002; Root-Bernstein et al., 2013). In contrast, specifying animal portrayals – representing animals at a low taxonomic level and making them recognizable – may not be deemed relevant for attracting customers to buy clothes or for conveying picture book stories.

8.3 The perspective of biodiversity communicators

In the third and final part of this thesis I have investigated the perspective of biodiversity communicators. Involving communicators in the research was highly valuable, as high-quality communication is seen as an important key in engaging lay audiences on biodiversity (CBD, 2013). Communicators have potential to sensitize people to the natural environment and they can aid people in expanding and specifying their perception of biodiversity and according vocabulary.

First, from the idea that being aware of existing perceptions in target audiences is vital for communicating effectively, I used an innovative approach to explore whether biodiversity communicators are aware of existing knowledge levels. While establishing the average level of species literacy in primary school children and professionals (Chapter 2), participating communicators were asked to make an estimation of children's knowledge level. Subsequently I could compare communicators' estimates to the actual level (**Chapter 6**). Furthermore, Chapter 6 discussed communicators' views on why knowledge about species would be important or not, and the desired level of species literacy. **Chapter 7** described a qualitative research project for which I carried out interviews with biodiversity communicators. I studied their views on the current and desired role of biodiversity in laypeople's lives, their experience with and thoughts about communication, and opportunities and challenges that they perceived in connecting people to biodiversity in the densely populated Netherlands.

Biodiversity communicators were aware that laypeople's current perception of biodiversity is limited. During the interviews discussed in Chapter 7, communicators described how they felt motivated in their work by laypeople's poor understanding, and they noted the ambivalent attitudes that Dutch citizens express towards biodiversity. They argued that opening people's eyes

for biodiversity would benefit both people and biodiversity, and they aimed for a bigger role of biodiversity in laypeople's lives. Still, as reported in Chapter 6, at a more detailed level I found that most communicators were unaware of the average knowledge level in primary school children aged 9/10 years old, whether they had experience with children as a target group or not. In particular, many respondents overestimated the average level of species literacy.

It was apparent from both projects that biodiversity communicators generally valued knowledge about species. As shown in Chapter 6, most desired the level of species literacy in children to be higher than the actual level. However, communicators disagreed on the components of species literacy that would be important, e.g. while some attached importance to naming species, others downplayed the value of knowing names. Moreover, some communicators seemed unaware of the role that factual knowledge can play in fostering understanding (Amer, 2006; Weilbacher, 1993), interest (Cosquer et al., 2012), and appreciation (Lindemann-Matthies, 2005; Schlegel & Rupf, 2010); e.g. some did not seem to grasp the value of species as tools to comprehend biodiversity and other complex concepts such as ecosystems and food webs (Barker & Slingsby, 1998; Orr, 2005). Others did note relations between knowledge, attitudes, and behavior, yet they seemed to overlook limitations of knowledge-deficit models (C. Mooney, 2010; Owens, 2000). Communicators' views further differed as to why species literacy would be important. For instance, some linked knowledge about species to broader understanding of nature, while others stated that species knowledge may stimulate interest and positive attitudes towards species.

Finally, as discussed in Chapter 7, communicators saw much potential in the Netherlands to engage people with biodiversity, an encouraging view at a time when the relationship between humans and nature is under increasing pressure and nature conservation is increasingly dependent on people living in urbanized environments. Based on communicators' views potential lies in a combination of direct experiences with biodiversity outdoors, the media, and education. Moreover, strategically designed communication holds keys in opening people's eyes for biodiversity. Still, despite this optimistic view on opportunities to expand the role of biodiversity in laypeople's lives, barriers were mentioned as well that will need to be overcome to fulfill the potential. For instance, people may be easily distracted from nature in crowded settings, biodiversity is integrated and regulated poorly in urban design, and accessibility to greenspace differs between



locations. Moreover, the interviewees noted that the media may distort views on biodiversity, and that schools face challenges such as low budgets. Some of these impediments to the experience of biodiversity will be discussed in the following section, where I describe practical implications of the findings.

8.4 Implications of the findings

The low level of species literacy that was uncovered in laypeople, especially in children, implies that a large part of the Dutch population currently does not derive the benefits associated with knowledge about species. Instead, they miss out on opportunities for enriching, joyful, and rewarding experiences with biodiversity, and the potential is unexploited to develop a sense of place through familiarity with local biodiversity (Horwitz et al., 2001; Standish et al., 2013). It will be difficult for people unaware of species to know how a species is faring, and to make judgements and informed decisions about policies and actions that may affect these species. Additionally, it is questionable whether current knowledge levels are sufficient for achieving ecological and environmental literacy (Barker & Slingsby, 1998; Cutter-Mackenzie & Smith, 2003; Roth, 1992), both of which are crucial in a world with a rapidly growing population that puts increasing pressure on the environment and poses a significant challenge to sustainable development (Bergaglio, 2017). Overall, a restricted perception of animal biodiversity affects laypeople's lives in multiple ways, but there are important implications for professionals too.

8.4.1 Implications for conservation

Possible effects on people's attitudes and behavior

For conservationists it is important to realize that people tend to care about what they know (Balmford et al., 2002; Schlegel & Rupf, 2010), and an inability to name species may lead to a loss of attention for them (Macfarlane, 2015, 2017). This raises concern for vulnerable species that received low identification rates, such as the black-tailed godwit. Biases in the types of animals that people do and do not know can influence which conservation initiatives and policies receive support (Davies et al., 2018; Wilson & Tisdell, 2005), and may impact directions for biodiversity research (Jarić et al., 2019; Troudet et al., 2017). Misconceptions

about species may also affect people's attitudes towards them. Species wrongly believed to be health risks, such as the non-venomous grass snake that was regularly thought to be venomous (Chapter 3), may experience persecution (Corbett et al., 2005). Limited understanding of species may further prevent people from making informed decisions and from personal actions that benefit species, e.g. people can aid animals that visit their garden effectively only if they are aware of their requirements (e.g. what would be suitable nesting sites or the kind of food they depend on).

From a conservation perspective, the current patterns in species literacy are further worrisome, because they suggest a disconnection of Dutch citizens from the local environment. Unfamiliarity with local biodiversity may lead people to think that conservation efforts abroad should be prioritized (Ballouard et al., 2011; Verboom et al., 2004). As people are likely to overlook animals that they cannot identify, people with a low level of species literacy may also undervalue biodiverse habitats (Shwartz et al., 2014; Weilbacher, 1993), may not notice declines in biodiversity, and may experience difficulty in making informed decisions with regard to such alterations. Indications of this have been pointed out in Chapter 7; the interviewees outlined examples of people unaware that invasive species had replaced native species, and of people having got used to shifted baselines. Such lack of awareness could hamper support for nature protection legislation and conservation measures. As low levels of species literacy can ultimately interfere with biodiversity conservation, conservationists should be aware of factors that drive people's perception of biodiversity.

The impact and potential of cultural representations

In this thesis I have demonstrated that cultural sources targeted at children paint a limited and distorted picture of the animal kingdom, and there is much evidence that this influences which animals people know. It even seems that the impact of such indirect exposure to biodiversity currently outweighs the impact of direct experience with biodiversity. As reported in Chapters 4 and 5, children's clothes and picture books overrepresented mammals and depicted them in greater specificity as compared to other animals, which suggests that they foster familiarity mostly with mammals. Moreover, cultural products seem to direct people's perceptions towards foreign species, as animals exotic to the Netherlands were featured frequently in picture books and childrenswear, and



native species were mistaken for exotic animals in the identification test.

Cultural portrayals of animals may impact conservation in different ways. First, people may develop affinity towards regularly featured animals at the expense of other animals. The focus on vertebrates and exotic species may lead people to think that invertebrates and native species are not worthy of their attention and support. This links back to children's higher interest in foreign animals as compared to animals that occur in the Netherlands. People may further overestimate the natural abundance of animals that are featured frequently, even when they are in fact threatened (Courchamp et al., 2018). People's view on animals can also be distorted by the artistic transformation that animals go through when they are portrayed in cultural sources. Compared to anthropomorphic animal characters real animals may appear dull, and the unequal attribution of human characteristics to different animal groups may trigger affectionate feelings for some (notably mammals) while others (e.g. invertebrates) may be perceived as mere objects (Cole & Stewart, 2016; Root-Bernstein et al., 2013). Unrealistic and anthropomorphic portrayals can further induce misconceptions, e.g. about behavior (Ganea et al., 2014; Geerds, Van De Walle, et al., 2016; Marriott, 2002; Waxman et al., 2014). In some cases this can undermine positive attitudes towards animals, e.g. people may approach wild animals that they recognize as 'friendly characters' (McCrinkle & Odendaal, 1994), and may wish to keep popular animal characters as pets (T. A. Clarke et al., 2019; Root-Bernstein et al., 2013).

Overall, the distorted and unspecified portrayal restricts current opportunities for Dutch children to familiarize themselves with animals through cultural products. However, as the current portrayal is likely to stem partly from a limited perception of animal diversity in cultural product makers, there is potential for a more diverse representation of animals. Of course, tendencies to depict mammals will not change easily, and as products such as clothes are destined for an international market, exotic animals will inevitably dominate. Still, opportunities remain, as the representation of such popular groups can be diversified and specified too. Partnerships with conservationists could encourage creatives to weave underrepresented species and animal groups into artwork and storylines or to highlight them in special or limited editions. Conservationists could further help educators in selecting products most suitable for expanding perceptions (e.g. picture books that portray the local environment).

Expanding opportunities for direct experiences with biodiversity

While urbanization continues and the gap between humans and nature widens, cultural representations of animals play an increasing part in people's daily exposure to biodiversity. However, animal portrayals still can best be regarded as a supplement rather than a substitute for outdoor nature experience, as the opportunities that they provide are restricted, e.g. due to the biases described above and the limited senses stimulated through vicarious experiences with nature. It is therefore vital that conservationists do not overlook the importance of facilitating direct experience with nature.

To offer people opportunities to engage with flora and fauna outdoors, biodiversity should be an integral part of urban design. It is vital that conservationists and urban ecologists are involved in the design process, not only because they can then directly influence plans, but also because they can educate important actors such as urban planners, architects and housing corporations about the importance of biodiversity and about strategic ways to incorporate biodiversity in the landscape or in architecture (Apfelbeck et al., 2020; Barrico & Castro, 2016; Parris et al., 2018). As such, false assumptions in these actors – e.g. that citizens would dislike natural types of greenspace and would dislike flora and fauna – can also be countered (Muratet et al., 2015; Vaske et al., 2011).

While offering room to biodiversity in cities could help people in having enriching interactions with species, it is important to reiterate that many laypeople were unfamiliar with animals that are common in the Netherlands and abundant in (sub)urban areas. As noted by interviewees in Chapter 8, biodiversity in the Netherlands may even be higher in cities than in rural areas, where biodiversity has declined. This links to McKinney (2008), who argued that moderately urbanized environments may have higher species richness than the native ecosystems they replaced. Instead of a lack of opportunity to experience species directly due to limited abundance, it is more likely that people's unfamiliarity with local biodiversity is caused by some of the barriers to outdoor experience mentioned in Chapter 7, such as urban distractions (e.g. traffic) and limited accessibility to greenspace.

Possibly people need certain types of greenspace where they can unwind and calmly take in the surroundings, in order to notice and enjoy species that actually occur outside of these locations too. During the interviews it was mentioned that locations differ with respect to the availability and accessibility of greenspace,



which links to Cox et al. (2017), who found that for urban residents in the UK the majority of human-nature interaction was experienced by only one third of the population. This may imply that a considerable part of Dutch citizens may not develop a strong, personal connection to nature (Cheng & Monroe, 2012), which could hamper conservation in the future (Soga, Gaston, Yamaura, et al., 2016). To counteract this, biodiversity sensitive urban design (Garrard et al., 2018) could help create areas of urban nature that allow valuable interactions between citizens and the natural world to unfold.

Additionally, communication will need to play an important role in opening people's eyes for what is around them.

8.4.2 Implications for communication

Restricted knowledge as a barrier to engagement

Although communication is acknowledged as an important pathway to connect people to biodiversity, significant challenges emerged from the research. First, the considerable knowledge gap between professionals and laypeople may hinder communication. Laypeople's low level of knowledge about native animals could make it harder to discuss biodiversity in a way that is locally relevant (Magntorn & Helldén, 2005), and as the majority of the Dutch public is aware of just a small range of animals, only specific species will resonate with the public when they are used as flagships in campaigns.

Furthermore, current levels of species literacy seem to be lower than communicators expect, as many communicators overestimated children's average level of species literacy. Current messages and materials may thus not align with existing knowledge. Species names wrongly presumed to be part of the vocabulary of the target group may act as jargon, so messages are misunderstood. Mismatches between communicators' assumptions of what audiences know and what they really know may partly explain why certain segments of the public have not yet been reached successfully (Elder et al., 1998).

An encouraging thought is that when communicators would become more aware of current knowledge levels in laypeople, this may generate momentum to combat the current lack of understanding. After all, most communicators desired an average level of species literacy in children that was higher than it actually was, they just were not aware that the knowledge level was as low as it was.

The value of species identification tests

To get to know and differentiate target groups, communicators could use knowledge assessments. In particular, my research has demonstrated the versatility and usefulness of species identification tests. As demonstrated in Chapter 3, species identification proves to be a decent impression of a person's in-depth knowledge about species, and may serve as an indicator of people's affinity with nature too. Moreover, in Chapter 2 we have seen that identification tests can be used to obtain information about the (dis)connection between people and the local environment, and about the likely impact of direct and indirect experiences with biodiversity on people's perceptions. The great enthusiasm exhibited by both young and adult respondents to participate in the tests suggests that such assessments can actually become quite popular, at least when they are presented as 'quizzes'.

Communicators could use a series of quizzes to explore knowledge levels and possible misunderstandings in their audiences. Such tests could be localized; e.g. school teachers could include species that their pupils encounter in the schoolyard. The results can help attune messages to an appropriate level and help address specific misconceptions, so that target groups are engaged more effectively on the topic of biodiversity. Of course, providing information at an appropriate level will in itself not be sufficient for changing people's attitudes and behavior (Buijs et al., 2008; J. H. Falk & Adelman, 2003), yet it is a start. In addition, factors such as interest, expectations, and personal experience with biodiversity can be examined with short tests, as they too influence people's response to messages.

Strategies in communication and education

Communicators may be inspired by the best practices in biodiversity communication as described in Chapter 7. First, and as noted above, professionals should aim to strike a chord with the public, e.g. by connecting to existing knowledge levels. Additionally, creative translation of biodiversity by using metaphors, mnemonics, and games can help people understand and remember messages. Careful selection of species to communicate can prevent cognitive overload while making sure that examples are accessible and relatable for people. In this regard it is advisable to embed species in context, as this is more likely to spark interest and can help achieve a more rounded understanding of



species, in line with Randler (2008), who posited that simple labeling of species as educational tasks may prove detrimental. Taking into account laypeople's shallow perception of biodiversity, I further point out that communicators can foster species literacy most effectively by being specific in their wording and the images they use for illustration.

In particular, young children are an important target group for communicators, as the average level of species literacy was found to be very low in these future decision makers. Moreover, childhood is a strategic starting point for raising biodiversity awareness, as children are generally open to information about nature and animals (DeMello, 2012; McCrindle & Odendaal, 1994), and through younger generations older generations (e.g. parents) can be reached too (Diris & Lambrix, 2010; Dixon et al., 2005; Remmele & Lindemann-Matthies, 2018). The most obvious place to educate children about biodiversity and to develop species identification skills will be at school, as many children can be reached via this route, including those with the least prior exposure to nature that will benefit most from such education (R. L. White et al., 2018).

Some of the communicators participating in the studies presented in Chapters 6 and 7 proposed to define a canon of animals that should become part of every person's knowledge base. This links to Pyle (2003), who argued that apart from literacy and numeracy, familiarization with the local environment should also be an important educational goal. Regardless of whether a biodiversity canon would be used or not, I do recommend to integrate species literacy in primary school curricula and to subtly weave animal diversity into different school subjects (e.g. biology, art, and language).

Communicators could inspire and support teachers by designing and proposing educational materials and accessible and affordable programs to observe and monitor species in the close vicinity to school. Such projects aimed at the local environment have been shown to expand children's perceptions of biodiversity and to foster positive attitudes towards native species (Lindemann-Matthies, 2005, 2006).

A framework for species literacy

Finally, it is important to consider the disagreement revealed among biodiversity communicators as to why species literacy would be relevant for laypeople. Some of the professionals seemed unaware of the range of values that knowledge about

species can offer to people, so they may not invest in raising species literacy in their lay audiences. As a consequence, the public may remain ‘species illiterate’ and the potential of species literacy will not be fully realized, which could ultimately make it harder to achieve broad-based biodiversity awareness. It is thus important that professionals grow understanding of the versatility of knowledge about species and the value it holds for laypeople.

To clarify and disseminate the concept of species literacy, I have constructed a framework. The framework shows the components of species literacy (Figure 8.1), the potential effects of species literacy on five personal domains (Figure 8.2), and a schematic overview of the hypothesized relationships between the personal domains and their connection to species literacy (Figure 8.3). By providing

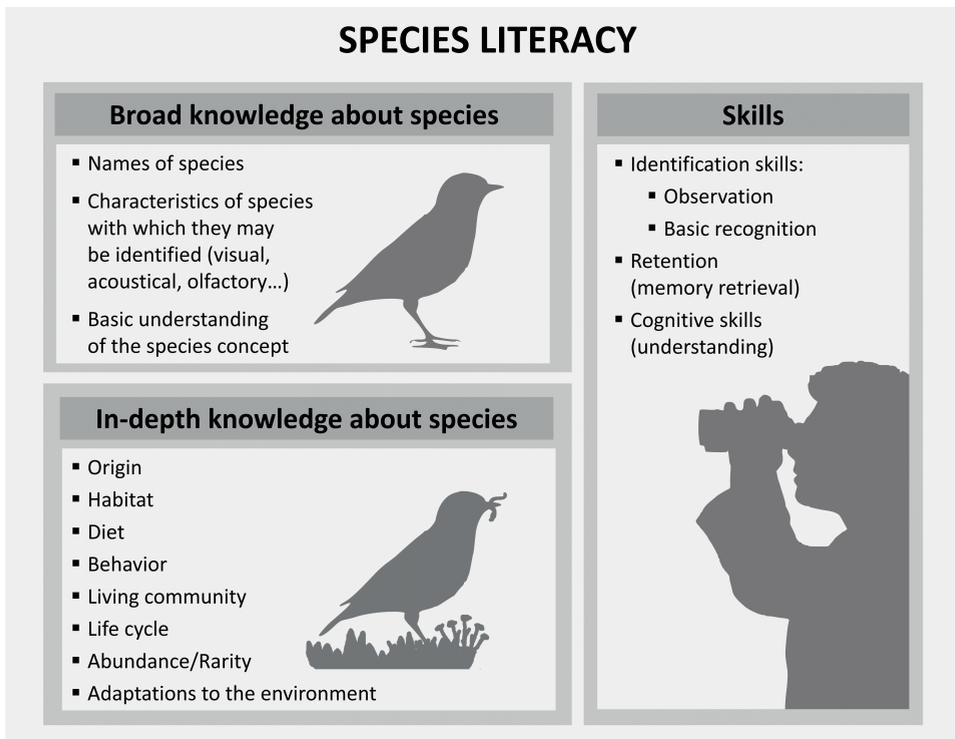


Figure 8.1 Schematic overview of the components of species literacy. Species literacy comprises broad as well as in-depth knowledge about species. It involves knowledge of facts, basic awareness and understanding, but also competences and skills, in particular species identification skills.

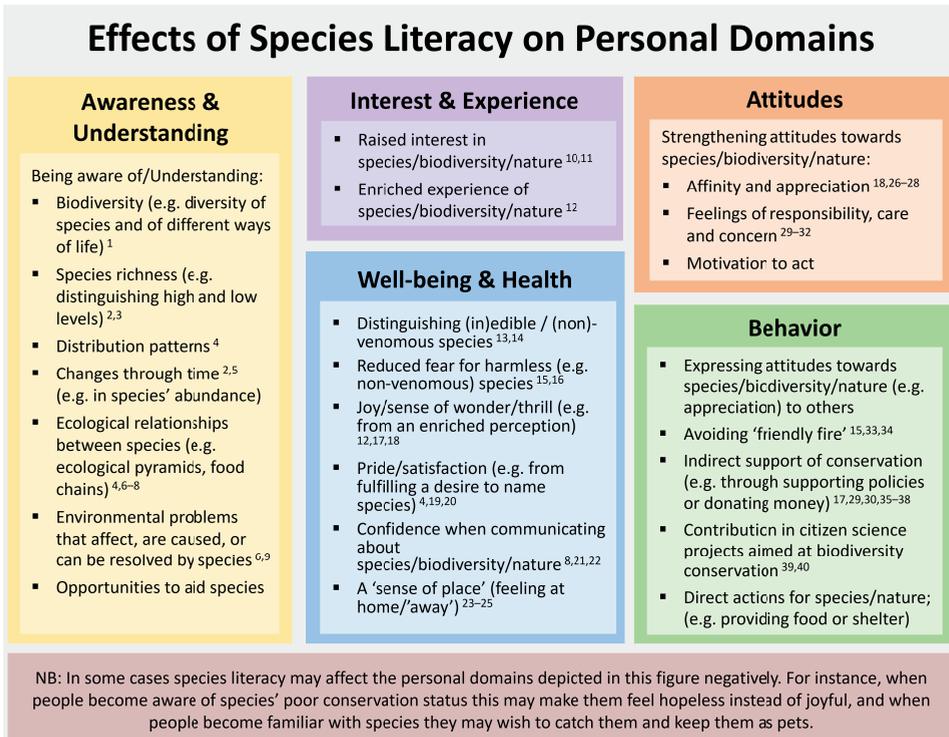


Figure 8.2 Potential effects of species literacy on five personal domains. 1: Elder et al. (1998); 2: Dallimer et al. (2012); 3: Schwartz et al. (2014); 4: Barker & Slingsby (1998); 5: Herzon & Mikk (2007); 6: Dayton & Sala (2001); 7: Magntorn & Helldén (2006); 8: Weilbacher (1993); 9: Patrick et al. (2013); 10: Cosquer et al. (2012); 11: Palmberg et al. (2015); 12: Ganzevoort & Born (2019); 13: (Corbett et al. (2005); 14: Fančovičová & Prokop (2011); 15: Alves et al. (2014); 16: Breuer et al. (2015); 17: Cox & Gaston (2015); 18: Wilson & Tisdell (2005); 19: Milstein (2011); 20: Tull (1994); 21: Magntorn & Helldén (2005); 22: Scott & Boyd (2014); 23: Buijs et al. (2008); 24: Horwitz et al. (2001); 25: Standish et al. (2013); 26: Lindemann-Matthies (2005); 27: Nates Jimenez & Lindemann-Matthies (2015); 28: Schlegel & Rupf (2010); 29: Balmford et al. (2002); 30: Bowen-Jones & Entwistle (2002); 31: Home et al. (2009); 32: Penn et al. (2018); 33: Olive (2014); 34: Somaweera et al. (2010); 35: Peterson et al. (2008); 36: Senzaki et al. (2017); 37: White et al. (1997); 38: White et al. (2001); 39: Genet & Sargent (2003); 40: Lepczyk et al. (2004).

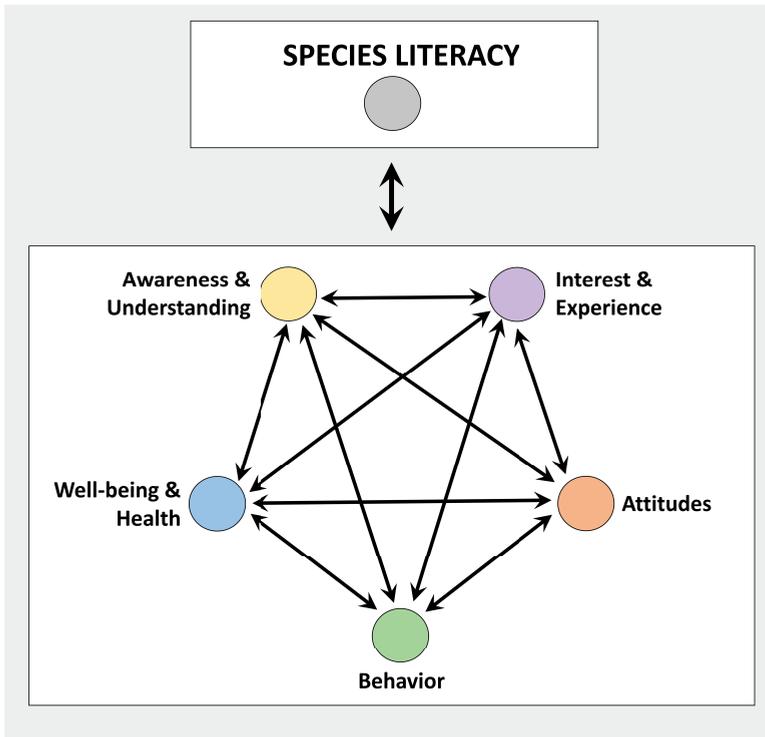


Figure 8.3 Model of the hypothesized relationships between the personal domains and their connection to species literacy. The model illustrates that species literacy and the personal domains influence each other reciprocally. Example cases can be thought of for each relationship. For instance, becoming aware that greenfinches exist and that they eat seeds (species literacy) can lead people to provide sunflower seeds for them in the garden during winter (behavior), which may attract other birds too, that people will subsequently become familiar with. Becoming aware of the diversity of life (broader awareness/deeper understanding) can instill a sense of responsibility (attitudes), and a feeling of responsibility may vice versa stimulate people to learn about environmental problems that affect species.



an overview of the contributions that knowledge about species can make to broader awareness and deeper understanding, interest, well-being, affection, and behavior, the framework can aid communicators in setting educational goals, and in underscoring the importance of their educational activities related to biodiversity awareness. Furthermore, distribution of this framework among researchers and communicators (e.g. at schools and conservation agencies) may generate impetus to study and foster species literacy in society.

8.4.3 Implications for future research

Whereas the restriction in laypeople's perception of animals holds significant implications in itself, the cross-sectional setup of the species literacy assessment did not reveal if and to what extent knowledge has actually been lost. Recent research in Germany has suggested that over a period of 12 years grammar students' knowledge about species declined by 15 percent (Gerl et al., 2021). Future longitudinal research could use species literacy assessments at regular intervals to track changes over time. This could elucidate whether the low level of species literacy in primary school children signals a growing distance between humans and nature. New studies on biodiversity awareness in the Netherlands could include a greater variety of invertebrates, amphibians and fish, and could incorporate taxa such as plants and fungi. Moreover, factors such as interest, expectations, and personal experience with biodiversity could be examined alongside knowledge levels. Projects that assess laypeople's perceptions could be strategically combined with research on professionals' awareness of these perceptions.

Future studies could further delve deeper into the different determinants of species literacy. The regression models presented in Chapter 2 for primary school children and the general public only accounted for part of the variance in laypeople's knowledge levels, and this suggests that there may be important drivers for species literacy that have yet to be uncovered. One of these factors may be 'green role-models' during childhood such as teachers, family members, and media personalities that mediate exposure to biodiversity. Remmele and Lindemann-Matthies (2018) demonstrated that children's and their parents' familiarity with species was positively related, although the relationship proved to be stronger for plants than for animals. More extensive scales to measure direct and indirect experience with biodiversity combined with qualitative research to

help grow understanding of the factors that impact people's perceptions would be valuable. In addition, projects could study the relationships depicted in Figure 8.3 between species literacy, broader awareness and deeper understanding of biodiversity, interest and experience, well-being and health, attitudes, and behavior. In this light it would be interesting to differentiate different components of species literacy (e.g. species' names, conservation status, and way of life), as these probably have different effects on people.

With regard to cultural representations of biodiversity some important questions also remain. First, future studies could investigate how cultural representations of animals vary and change through time, and how products and media targeted at adults differ from those aimed at children. Beyond the taxa and types of animals that are depicted, and the specificity of their portrayals, such studies could also examine the portrayal of habitats, behaviors, diets, and living communities. Moreover, researchers could determine to what extent people, notably children, are aware of animals that they encounter as cultural representations. While images of animals unquestionably affect people's views on animals, laypeople are less likely than professionals to link highly transformed animal figures to the animals that they represent, and the exact impact on species literacy is currently still unknown. A valuable line of inquiry would further be to investigate how portrayals of the natural world influence people's predisposition towards engaging with the outdoors. On the one hand portrayals may trigger interest and an inclination to explore, yet on the other hand local biodiversity may appear dull and unrewarding after exposure to spectacular or comical images of animals. Finally, a promising avenue for further investigation of cultural products is to study how the portrayal of animal biodiversity can be diversified, through preference-tests with consumers, and also through in-depth interviews with creatives, to uncover the processes that determine their subject and design choices.

Finally, we need continued efforts to map opportunities and barriers to connect laypeople, children especially, with the local environment. Future research could explore how teachers and parents can best be supported in educating children about native biodiversity. In this respect it is important to note that opportunities and challenges to the experience of nature differ between contexts. Educators at schools in city centers or in low socio-economic neighborhoods face different challenges as opposed to educators in rural settings and high-socio-economic



environments, which shows the importance of localized case studies. From the idea that biodiversity sensitive urban design can ultimately help open people's eyes for biodiversity and help them connect with nature, mixed-method setups are further needed that study biodiversity awareness in actors such as landscape architects and housing corporations, and its impact on urban planning.

8.5 Synthesis

In this thesis I have outlined the results of six empirical research projects focused at biodiversity awareness in the Netherlands. Through my studies I have demonstrated that the perception of animal biodiversity is limited in the Dutch lay public. Primary school children in particular seem to be species illiterate. They regularly failed at identifying common and conspicuous animals, which points to a lack of familiarity and connection with the local environment.

Knowledge patterns mirrored the patterns uncovered in cultural portrayals of animals. Animals well known by people, such as mammals and species exotic to the Netherlands, predominated children's fashion and picture books, while animals such as birds and butterflies that were portrayed less frequently and in less specific manners, were hardly in laypeople's minds. As such, the findings of my research on cultural representations of animals align with the findings of my research on perceptions of animal biodiversity: both reflect a gap between people and nature. The animals that people do know are quite difficult to experience directly, either because of their reclusive lifestyles (native mammals) or their foreign origins (exotic megafauna from overseas), while species that people can easily encounter outdoors seem to go by unnoticed.

The revealed patterns imply that Dutch laypeople currently miss out on enriching experiences with biodiversity. Laypeople's restricted and biased perception further poses a challenge for conservationists, who ultimately depend on the public for broad-based support, and for communicators, who play an important role in connecting people to the natural world. Based on my research, promising avenues to foster species literacy and engage people with biodiversity are 1) realizing opportunities to experience biodiversity outdoors and in education, 2) diversifying cultural representations of animals, and 3) deploying strategically designed communication.

To realize the potential of these pathways, conservationists, communicators, and researchers should:

- ...study, become aware of, and disseminate to both professional and lay audiences the values of species literacy, to fulfill the potential of knowledge about species
- ...use tools such as species identification tests to get to know target groups and apply best practices in communication, to boost public engagement with biodiversity
- ...encourage schools to integrate species literacy in the curriculum and provide them with appropriate educational materials, to improve nature education and raise biodiversity awareness
- ...make sure to be involved in urban planning, to achieve biodiversity sensitive urban design
- ...inspire creatives to diversify and specify their portrayals of the natural world, to increase the educational contribution of cultural representations

Following these recommendations can help nurture lasting connections with biodiversity that will enrich people's lives and will help support conservation of the great diversity of life on our planet.

