

Article

Species Knowledge About a UNESCO Natural World Heritage Site and the Importance of Connectedness with Nature

Ricardo Puppe ^{1,*} and Till Schmäing ²

¹ Didactics of Science Education for Primary Schools, Paderborn University, 33098 Paderborn, Germany

² IPN—Leibniz Institute for Science and Mathematics Education, 24118 Kiel, Germany;
schmaeing@leibniz-ipn.de

* Correspondence: ricardo.puppe@uni-paderborn.de

Abstract: Species knowledge of local animal species is of great importance for one's own environmental awareness and is a major component for managing present and future crises in education for sustainable development. For this reason, this study is the first to survey the species knowledge of visitors to the UNESCO Natural World Heritage Site the Wadden Sea of the North Sea, which is the largest mudflat area in the world. In this context, the self-assessment of the respondents and the extent of their connectedness with nature are also examined. To answer the research questions, a questionnaire survey was carried out to determine the species knowledge and degree of connectedness with nature. For data analysis, various statistical methods such as *t*-tests and correlation analyses were used. The results show that the 126 visitors to the Wadden Sea Visitor Centre have a rather low level of species knowledge. In this regard, the European Herring Gull is the only very well-known species among the respondents. In addition, a further construct was investigated in the form of connectedness with nature, between which a significant positive correlation was found with species knowledge.

Keywords: species knowledge; connectedness with nature; Wadden Sea; UNESCO Natural World Heritage



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1. Introduction

The extinction of animal and plant species is not a new development, e.g., [1,2]. The enormous speed of the current decline in biodiversity, which is caused by human activity, is on an unprecedented level [3]. This anthropogenic influence contributes to the decline in species populations through, for example, habitat destruction, illegal trade and the introduction of invasive species [3,4]. Another influencing factor that is becoming increasingly relevant for changing biodiversity and species declines is climate change [5,6]. These factors, among others, are responsible for the fact that 3 to 130 species are currently going extinct per day [2]. Species knowledge is said to have great potential to prevent the loss of biodiversity [7,8]. It can contribute to the development of solution strategies to deal with biodiversity loss [7]. Although species knowledge is of great importance and relevance for nature and species protection, human knowledge of species is not adequately researched [9]. In previous studies on research into the development of species knowledge, the main focus has been on research in a school educational context. Most studies, e.g., [10–13], examine the species knowledge of secondary school students. The majority of studies, e.g., [7,13,14], illustrate a low level of species knowledge among primary and secondary school students. In addition, some studies [15–17] focus on university education. For example, studies [16,17] found a low level of species knowledge among nature science students in

teacher training. Beyond the formal educational context, research in the field of species knowledge takes place by people interested in nature [9] or species experts [18]. Among the groups of people described, not only a lack of species knowledge [14,16,19] but also a decline in species knowledge [7,18,20–22] has been observed. These results were measured in groups of people who have either been specifically educated at school or university or are experts who work in this field or are involved in species conservation. There are hardly any studies on the species knowledge of the rest of the population. Two of the few exceptions focused on native bird species [19] and native trees and invertebrates [23]. None of the studies cited investigated the species knowledge of the mainly adult population on an ecosystem-specific basis, i.e., species of different taxa within an ecosystem. This research gap is the entry point for investigating species knowledge in the present study with a linked connection to a local ecosystem, the Wadden Sea, a Natural World Heritage Site.

The choice of the Wadden Sea of the North Sea can be explained by the regional and global importance of the ecosystem [24]. It is the world's largest tidal flat area [25], which is home to more than 10,000 animal and plant species [26]. Internationally important representatives include the lugworm (*Arenicola marina*), which is of medical relevance due to the high oxygen transport function of its haemoglobin [27]; or bird species, some of which are permanently present, such as the European herring gull (*Larus argentatus*) or the oystercatcher (*Haematopus ostralegus*), as well as migratory bird species such as the arctic tern (*Sterna paradisaea*) or the knot (*Calidris canutus*). For those migratory birds, the Wadden Sea acts as a "hub of international bird migration" [28]. Many of the species mentioned can be observed on a mudflat hiking tour. Due to its ecological relevance, the Wadden Sea is protected nationally in Denmark, Germany and the Netherlands, but also internationally as a UNESCO World Heritage Site [29]. The Wadden Sea is also an important out-of-school learning site for education for sustainable development [30–32] and a valuable topic for science lessons in schools [33,34]. Furthermore, empirical educational research already provides findings on the species knowledge of prospective teachers about this ecosystem as well as a suitable measuring instrument for surveying this construct [17]. In addition to this content-related justification for the selection of the Wadden Sea, there are also research methodological points of reference in the literature. This study therefore examines the extent of visitors' species knowledge regarding this UNESCO World Heritage Site, including various influencing factors. Further aspects of the investigation are the knowledge of the individual species and a potential connection between species knowledge and the construct of connectedness with nature, which is extremely relevant for the context. For this purpose, the survey took place at the Wadden Sea Visitor Centre in Cuxhaven, which is an educational centre in a tourist region that can also function as an out-of-school learning location. Accordingly, the target group for this work is visitors. The Wadden Sea region is visited by around 10 million overnight guests and 30 to 40 million day tourists every year [26]. These people, who spend time in the ecosystem, can be sensitised to ecological behaviour and made enthusiastic about nature through appropriate educational offers [35].

1.1. Species Knowledge

Carl von Linné approached the concept of species in 1751 and described a species as the smallest unit in the biological system [36]. In addition to this description by Linné, there are other possibilities to define the concept, although it is clear that no standardised definition exists today [21]. For this reason, various species concepts exist simultaneously. The most common species concepts are the morphological, population-genetic and phylogenetic species concepts. All three approaches have different advantages and disadvantages in various contexts. For the present study, the morphological species concept is used. In

the following, the background to the morphological concept of species is explained with reference to [21]. The morphological species concept provides for the classification of individuals of a species according to their visible characteristics. This is used in field studies, identification literature and curricula, which explains its high relevance for science, society and education. The morphological species concept can be found in most study designs in the form of illustrations or drawings, in which reference is made to the essential external characteristics of a species to identify or distinguish it [19,21]. The pragmatism of this approach proves to be accessible to laypeople and, consequently, to the general public [21].

Various skills are useful for determining species and species knowledge. Dealing with species requires intrinsic motivation and skills such as patience, the ability to observe and the will to be accurate [37]. Teaching species knowledge has long been recommended from childhood onwards; for example, positive experiences of nature in childhood contribute to a commitment to nature conservation and environmental protection in adulthood [38]. In this context, more distinct species knowledge leads to a greater appreciation of the recognised species [39]. It also promotes the understanding of natural relationships [22]. Furthermore, species knowledge has an impact on physical and mental health as well as personal satisfaction [40].

In earlier centuries, species knowledge was of the highest relevance as food or medicinal herbs were increasingly collected from nature [37]. Nowadays, it is no longer necessary to deal with the relevant plants in this form, while the necessary requirements can be purchased in (online) shops. These rare experiences of nature are mentioned as one reason for the decline in children's species knowledge [7]. This lack of engagement is supported by the lack of teaching in schools and universities [22,41]. The decline in species knowledge is particularly linked to the current education system at universities, the fast pace of society and more difficult organisational reasons at schools [20,37]. In addition, the fear of many teachers that their own species knowledge is limited is cited as a further reason [20,42]. In the context of decreasing species knowledge environmental education centres, nature experience offers and the media are seen as relevant for increasing interest in biodiversity [43]. Insofar as this is triggered in people, this can have a positive effect on people's species knowledge.

The concept of species knowledge must be distinguished from the concept of species literacy, which also focusses on species identification. The concept encompasses both broad and in-depth species knowledge [14]. In addition to the naming of species, various learning domains such as knowledge of facts as well as competences and skills such as the observation of species or the application of knowledge are considered [14].

Various methods can be used to determine species knowledge, e.g., the assessment of actual species knowledge or self-assessment. Regarding the different methods, there are different findings on whether they lead to the same results [11,13,44]. On the one hand, negative correlations between self-assessment and 'actual' species knowledge were found [11,13]. According to one of the studies, students in Berlin rated their own species knowledge significantly higher than it actually was [13]. On the other hand, results show that school students were able to rate their own species knowledge as trustworthy [44].

1.2. Connectedness with Nature

In general, connectedness with nature describes the relationship between people and nature [45]. According to Flade, connectedness with nature is a personality-related disposition that is based on a system of experiences, views, beliefs and values regarding scenic or settlement-related nature [46]. It is further pointed out that connectedness can manifest itself in emotional, cognitive, motivational and behavioural aspects. Consequently,

it is a personal attitude towards nature that is subject to change, for example, due to changing environmental conditions. Schultz [47] describes that connectedness with nature refers to the extent to which an individual includes nature in their cognitive conception of the self.

There are different findings in the literature regarding the various factors that influence people's connectedness with nature. For example, older studies from the 1970s and 1980s show that there is no significant correlation between connectedness with nature and age, gender and school education [46]. In contrast, another study [48] was able to determine a decrease in students' connectedness with nature with age. In addition, more recent findings show that the degree of connectedness with nature is dependent on gender [49–53]. The studies cited show that women have a stronger connectedness with nature than men. Schmäing and Grotjohann [31] found that primary experiences with the Wadden Sea can compensate for this gender-specific characteristic in secondary school students in the short and long term. Furthermore, the relevance of childhood experiences of nature for adults' connectedness with nature has been recognised. More frequent experiences in nature during childhood lead to a higher level of connectedness with nature in adulthood [54]. In this context, too, primary experiences in nature have an effect on connectedness with nature.

Based on the importance of connectedness with nature as a predictor of ecological action [55,56], the relationship between species knowledge and connectedness with nature among student teachers has already been investigated [17]. The cited study found a significant correlation between the two constructs, with species knowledge being more pronounced the stronger the connectedness with nature towards the Wadden Sea ecosystem.

2. Materials and Methods

2.1. Research Questions

In this study, five different research questions are considered in accordance with the theoretical background and the objectives of this study. The focus of the research questions is on the degree of species knowledge (research questions 1 and 2) and possible correlations (research questions 3 and 5) and distinctions (research question 4), particularly with the important factor of nature experience.

Research question 1: How distinct is the species knowledge of visitors in the region about species of the Wadden Sea ecosystem?

Research question 2: How well known are the individual species to the visitors?

Research question 3: Is there a correlation between the visitors' knowledge of the Wadden Sea ecosystem and their self-assessment?

Research question 4: Do visitors who have already taken part in a Wadden Sea mudflat hiking tour have a higher level of species knowledge than visitors without this previous form of primary experience?

Research question 5: Is there a correlation between visitors' species knowledge about the Wadden Sea ecosystem and the extent of their connectedness with nature?

2.2. Sample

The survey was conducted at the UNESCO World Heritage Wadden Sea Visitor Centre in Cuxhaven. A total of 126 visitors took part in the study. Of these, 51 were male (40.48%) and 75 were female (59.52%). The average age of the respondents was 47.12 years ($SD = 20.24$). At the time of the survey, the youngest person was 12 years old and the oldest

was 77 years old. The respondents came to the Wadden Sea Visitor Centre in Cuxhaven from almost every federal state in Germany. Most of them come from North Rhine-Westphalia ($n = 34$) and Lower Saxony ($n = 26$). In addition, eight participants who live abroad took part, including six participants from Switzerland and one participant each from Finland and the USA.

2.3. Measurement

Species knowledge of the Wadden Sea ecosystem was assessed using a measuring instrument that was developed and successfully used in a previous study [17]. This instrument comprises three different animal species in each of the five groups of crustaceans, molluscs, mammals, snails, birds and worms. This means that a total of 18 different species are included. The respondents were asked to identify the species using a coloured scientific drawing. Table 1 provides an overview of the species that represent the species knowledge of the Wadden Sea ecosystem.

Table 1. Description of the 18 animal species of the survey.

Animal Group	Species Term	Latin Species Term
Crustaceans	Common Shore Crab	<i>Carcinus maenas</i>
	Common Shrimp	<i>Crangon crangon</i>
	Common Hermit Crab	<i>Pagurus bernhardus</i>
Mussels	Common Cockle	<i>Cerastoderma edule</i>
	Common Mussel	<i>Mytilus edulis</i>
Mammals	Soft-Shelled Clam	<i>Mya arenaria</i>
	Common Seal	<i>Phoca vitulina</i>
	Grey Seal	<i>Halichoerus grypus</i>
Snails	Common Porpoise	<i>Phocoena phocoena</i>
	Laver Mud Snail	<i>Hydrobia ulvae</i>
Birds	Edible Periwinkle	<i>Littorina littorea</i>
	Common Whelk	<i>Buccinum undatum</i>
Worms	European Herring Gull	<i>Larus argentatus</i>
	Eurasian Oystercatcher	<i>Haematopus ostralegus</i>
	Eurasian Curlew	<i>Numenius arquata</i>
	Lugworm	<i>Arenicola marina</i>
	Estuary Ragworm	<i>Hediste diversicolor</i>
	Sand Mason	<i>Lanice conchilega</i>

In addition, visitors' species knowledge can be determined by self-assessment. The visitors' self-assessment of their own species knowledge was surveyed for the third research question using a single item. Participants were asked to rate their personal species knowledge on a four-point Likert scale as 'low', 'rather low', 'rather high' or 'high' [17].

Another question that visitors were asked to provide was whether they had taken part in a mudflat hiking tour at this UNESCO World Heritage Site. It is based on an item for surveying tourists specifically for this ecosystem [57].

The Inclusion of Nature in Self (INS) Scale by Schultz [47] was used to determine connectedness with nature. It is characterised by the fact that it contains only one item that can be used to determine this construct. This is a validated item that has already been used in several studies [17,48,58]. The INS scale presents seven possible answers and is linked in this survey to the question: 'How closely are you connected to nature?'. The respondents are asked to select a visualisation that best describes their connectedness with nature. The simple visualisation takes the form of two circles, with one of the circles containing the word 'I' in the centre and the other containing the term 'nature'. In the seven visualisations, the two circles do not overlap at all, while they overlap more and more until they overlap

completely. As a result, the last visualization has the most distinctive connectedness with nature, while this is almost non-existent in the first option.

2.4. Analysis Method

The first research question was answered by using an existing test consisting of 18 items to determine the level of species knowledge of Wadden Sea Visitor Centre visitors. The analysis of the species knowledge test was based on the implementations in other studies [10,12,13,17,19,59]. Therefore, points were awarded. One point was awarded for each correct naming of the corresponding animal species, so a maximum of eighteen points could be scored in total. If a higher-level taxon was named correctly, the respondent received half a point.

To address the second research question, the respondents' points are added up for each species, resulting in a total score ranging from 0 to 126 points. In addition, according to previous studies [19], the recognition rate of the individual species can be determined. To do this, all the points for a species are added together and divided by the number of test subjects. The percentage familiarity value of each species is considered very familiar by 100–75%, rather familiar by 74–50%, rather unknown by 49–25% and unknown by 24–0% [19]. In the case that respondents gave more than one species name, the answer was considered invalid and was scored accordingly with 0 points.

A correlation analysis was carried out to answer the third research question (potential correlation between species knowledge and self-assessment) and fifth research question (potential correlation between species knowledge and connectedness with nature). The correlation coefficient r is used to determine the strength of the statistical relationship. The statistical correlation is categorised as relatively small from $r = |0.1|$, typical from $r = |0.2|$ and relatively large from $r = |0.3|$ [60]. The correlations are tested for significance ($p = < 0.05$).

To analyse the fourth research question, the sample was divided into people with and without prior participation in a mudflat hiking tour using a quasi-experimental design. A t -test was carried out to determine the possible difference between the two groups. This requires a normal distribution, which can be assumed due to the sample being sufficiently large ($n > 30$). A further prerequisite is variance homogeneity, which can be checked using the Levene test. When carrying out this t -test, variance homogeneity can be assumed as the Levene test is not significant.

3. Results

The results are presented below according to the five different research questions.

3.1. Species Knowledge of Visitors

The participants have achieved an average of $M = 6.62$ ($SD = 3.18$) out of 18 points. This corresponds to a percentage value of 36.79%. The highest score reached was 17.5 points, while the lowest score reached was 1 point.

3.2. Familiarity of the Individual Species Knowledge

The familiarity of the individual species is shown in Table 2. Of the selected species, the European herring gull is most known. It was recognized by 76.98% and is the only species classified as very familiar. This is followed by the Common Seal with a recognition rate of 65.08%, the common hermit crab (56.75%) and the common cockle (56.35%). The first four species were recognised by more than half of the test subjects. In contrast, the remaining 14 animal species were identified by less than half of the respondents. A total of 5 of the 18 species were categorised as unknown. This concerns the Eurasian curlew, the

large periwinkle, the whelk, the iridescent sea ringworm and the tree tubeworm. Of all the species, the tree tube worm was recognised the least (5.56%).

Table 2. Results of the second research question.

Species	Score	Percent	Familiarity Score
European Herring Gull	97	76.98	very familiar
Common Seal	82	65.08	rather familiar
Common Hermit Crab	71.5	56.75	rather familiar
Common Cockle	71	56.35	rather familiar
Common Porpoise	61	48.41	rather unknown
Common Shore Crab	58.5	46.43	rather unknown
Common Mussel	57	45.24	rather unknown
Lugworm	55.5	44.05	rather unknown
Eurasian Oystercatcher	53.5	42.46	rather unknown
Grey Seal	53	42.06	rather unknown
Soft-Shelled Clam	38.5	30.56	rather unknown
Common Shrimp	33.5	26.59	rather unknown
Laver Mud Snail	33	26.19	rather unknown
Eurasian Curlew	25	19.84	unknown
Edible Periwinkle	14	11.11	unknown
Common Whelk	13	10.32	unknown
Estuary Ragworm	10.5	8.33	unknown
Sand Mason	7	5.56	unknown

3.3. Connection Between Species Knowledge and Self-Assessment

The average self-assessment of species knowledge is $M = 2.18$ ($SD = 0.77$; $n = 124$). The arithmetic mean is slightly above the value 2, which is verbalised as 'rather low'. In the self-assessment, 20 respondents (16.13%) rated their own species knowledge as 'low' and 69 respondents (55.65%) as 'rather low'. In comparison, 35 respondents were above the mean value, with 28 respondents (22.58%) rating their own species knowledge as 'rather high' and 7 respondents as 'high' (5.65%), which is shown in Table 3.

Table 3. Results of the self-assessment of species knowledge.

Level of Own Species Knowledge	Number	Percent
High	7	16.13
Rather high	28	55.65
Rather low	35	22.58
Low	69	5.65

The correlation analysis was carried out to determine the potential correlation between the self-assessment and the identified species knowledge. The associated Pearson correlation is 0.25. According to the correlation coefficient r , this is a typical statistical relationship. The significant result ($p = 0.04$) confirms the positive correlation between the self-assessment and the identified species knowledge. This means that the higher the self-assessment of one's own species knowledge, the higher the species knowledge determined.

3.4. Influence of Former Mudflat Hiking Experiences

The descriptive statistics illustrate that the subsample of visitors who had already taken part in a mudflat walk had a higher average level of species knowledge ($M = 6.95$; $SD = 3.36$; $n = 76$) compared to the group of people who had not previously taken part ($M = 6.13$; $SD = 2.88$; $n = 49$). The result of the Levene test is not significant ($p = 0.10$), which

is why variance homogeneity can be assumed. The stated difference in mean values is not statistically significant ($t(123) = 1.40$; $p = 0.165$).

3.5. Correlation Between Species Knowledge and Connectedness with Nature

The average level of connectedness with nature is $M = 4.54$ ($SD = 1.09$). A relatively small correlation was determined using a correlation analysis ($r = 0.184$). This statistically significant result ($p = 0.04$) confirms the positive correlation between connectedness with nature and species knowledge.

4. Discussion

This research work has been able to replicate the theoretical contradiction between the theoretical relevance of species knowledge, e.g., [37,39,41], and the lack of species knowledge in practice, e.g., [7,18,59], for the first time for the species knowledge of visitors within an ecosystem. In this study, 126 visitors to the UNESCO World Natural Heritage Site took part. Therefore, it should be considered that the sample size could be larger. However, the sample size is large enough to determine statistical significance. Although it should be noted that different samples and measurement instruments may relativise comparability, the result of visitors' low level of species knowledge can be compared with other study results. The most meaningful comparison is with the study by Schmäing and Grotjohann [17], as the same survey instrument with the same content was used. The visitors surveyed in this study have a higher average level of species knowledge (approx. 36.79%) compared to the prospective teachers of biology and general studies surveyed in the previously cited study (approx. 30.06%). Its authors refer to the results of the student teachers as a 'low level of species knowledge', which can be transferred to the species knowledge of visitors because only slightly more than one out of three animal species were correctly identified in this survey. The fact that the species knowledge of people visiting the Wadden Sea Visitor Centre Cuxhaven is higher than that of university student teachers illustrates the mentioned deficits in teacher training [15–17].

The reasons for visitors' greater knowledge of the Wadden Sea ecosystem can only be assumed and should therefore be explored in future studies. One possible reason is the local neighbourhood of the Wadden Sea ecosystem. This survey took place directly on site in the Wadden Sea region, while the student teachers were asked at a university about 300 km away from the Wadden Sea. This suggests that visitors are likely to have a higher level of primary experiences in this ecosystem. In addition, a thematic examination of some species of the Wadden Sea could have taken place close to the time of the survey. It is therefore possible that the participants took part in a mudflat hiking tour directly before the survey and, for example, lugworms were identified. However, this factor was not surveyed in the present study. This approach may serve as a future aspect for investigation. Another positive influencing factor could be the implementation of the survey in a visitor centre for the Wadden Sea, which has great potential to promote species knowledge with its exhibition and educational offers [37]. Nevertheless, the average level of species knowledge among visitors is low. This becomes clear when compared to the two Species | Pisa studies [9,61]. In these Species | Pisa studies, the average species knowledge was 49% (2017) and 48% (2019), which shows that visitors performed comparatively worse. In this comparison, it must be considered that the Species | Pisa studies surveyed samples interested in nature, which could partly explain the higher values compared to this sample.

The need to act is a result of the rather low level of species knowledge. A key implementation measure is to raise awareness of species knowledge among the public, to trigger an interest in this area and to promote it [62]. In addition to expanded education in species knowledge for young people in schools, e.g., [13,22], this work also highlights

the importance of exhibitions [22] and nature conservation centres [18]. There is also a need to promote educational institutions such as the Wadden Sea Visitor Centre to trigger interest in species knowledge. For this purpose, such educational institutions should be increasingly integrated as out-of-school learning centres in everyday school and university life as well as in tourism offers. The low level of species knowledge about the Wadden Sea ecosystem in higher education and tourism shows the need for an education and research offensive [7,18,37].

Considering the familiarity of the individual species, only the herring gull can be rated as very familiar. The high level of familiarity is in line with the findings of a comparable study [17]. This result can be linked to the fact that herring gulls are also common in many places in Germany outside the coastal region [63]. It is noticeable that the eight most frequently recognised species correspond to those in the study by Schmäing and Grotjohann [17], although in a different order. This result confirms the familiarity of the individual species. The result of the relatively high familiarity of mammals is consistent with the findings of other studies [14,21]. The comparatively high familiarity of mammals in this study can be linked to the small number of different mammal species in the Wadden Sea and the familiarity of grey seals and harbour seals as 'Germany's largest predators' [64]. The values for the familiarity of mammals and birds among visitors almost correspond to the interest of young people in the animal groups mentioned [65]. Similarly, the average familiarity of bird species among visitors (46.43%) corresponds to similar familiarity values in a comparable study (45.93%) [19]. In contrast, the familiarity of mussels among visitors does not match the interest in more species knowledge about this animal group among young people. Instead, the comparatively high level of familiarity is reflected, for example, among school students and student teachers [17,29], which is why a discrepancy between familiarity and popularity among young people can be assumed. The comparatively higher familiarity of the species groups can be linked to the aspect of relevance to the real world and better observation opportunities [44].

In this study, it is important to consider that the species included are native to the Wadden Sea ecosystem but may be unfamiliar to the target group due to their different backgrounds. This aspect is a limitation, which is why further background information such as the duration and quality of the visits would make it possible to categorise the results more precisely. Nevertheless, this result serves as an opportunity to extend research into species knowledge to other ecosystems. For this purpose, other important ecosystems such as the UNESCO World Natural Heritage Site Beech Forest or the mangroves in the UNESCO World Natural Heritage Site Sundarbans would be suitable. In this way, the level of knowledge about the extent of species knowledge in the population can be expanded and placed in relation to this study.

Another result of the study is the significant positive correlation between the self-assessment and the determined species knowledge of native animal species of the Wadden Sea ecosystem. This result supports the findings of another study [44] investigating the correlation between self-assessment and actual knowledge of plant species. Accordingly, for the first time, a significant positive correlation between self-assessment and the identified species knowledge of animal species in a specific ecosystem could be proven. The result indicates that visitors can reliably assess their own species knowledge. Most respondents are aware of the low level of species knowledge.

The results on the influence of previous participation in a mudflat hiking tour on visitors' species knowledge indicates, on the one hand, that a higher level of species knowledge can be argued based on the mean value. This result supports the importance of primary experiences, e.g., [34,42]. On the other hand, the difference is not statistically significant, which is consistent with other findings [7]. The contradictions identified and

described in the theory indicate the need for further research into the influence of primary experiences. The fact that people who have already taken part in a Wadden Sea hiking tour have a higher average level of species knowledge indicates that additional factors have an influence on species knowledge. For example, it can be assumed that the quality of nature experiences is relevant for the level of species knowledge in primary experiences in the Wadden Sea region [7]. This survey was limited to recording the quantity of participating mudflat walks, while the qualitative component of the relevant factors was not considered. For example, different mudflat guides, the diversity and abundance of the species seen, and local conditions could have an influence on the quality of a mudflat hiking tour. For further research, it is recommended to analyse the quality of interventions on species knowledge. In this context, the Wadden Sea region should be prioritised as an out-of-school learning location [66]. The demand for educational offers in tourism is illustrated by the results of the SÖM-Watt report from 2018, which shows that 73% of holidaymakers surveyed ‘want to learn something specifically about nature at their holiday destination [...]’ [57]. As a result, an expansion and specification of the existing educational offers regarding the teaching of species knowledge for the areas of tourism, schools, universities and adult education is required.

This study can replicate the significant result between the species knowledge and the connectedness with nature of student teachers [17]. Compared to the student teachers at Bielefeld University ($M = 4.20$), visitors ($M = 4.54$) show a higher level of connectedness with nature. Once again, the local neighbourhood of this study to the important Wadden Sea region, which is characterised by biodiversity and nature conservation measures, can be cited as a possible explanation. The significant correlation between species knowledge and connectedness with nature illustrates the importance of this construct. For this reason, it is important to enable affective experiences of nature, as these contribute to stronger connectedness with nature [48]. This requires a ‘rapid educational offensive’ [7], which promotes affective experiences of nature and the teaching of species knowledge. Accordingly, excursions and school trips to the Wadden Sea region are particularly suitable for increasing connectedness with nature and species knowledge [17]. Other experiences in nature such as forest walks, animal observations or visits to other out-of-school learning locations can be considered to promote connectedness with nature [67].

5. Conclusions

This study provides initial findings on the species knowledge of people visiting a visitor centre on the Wadden Sea ecosystem and makes an important contribution to the literature with the implications it draws. Given the result of this study, that species knowledge is low among the analysed target group of visitors to the Wadden Sea for the first time, this study joins a large number of studies investigating the species knowledge of schoolchildren, (prospective) teachers, nature enthusiasts and species experts. This finding emphasises the need for further research into the species knowledge in general and the Wadden Sea ecosystem. This study should therefore act as an initiative to realise comparable studies in the future that investigate ecosystem-specific species knowledge within the specific ecosystem. For example, a study on species knowledge in the UNESCO World Heritage Site Beech Forest or on the mangroves in the UNESCO World Heritage Site Sundarbans could be conducted. In this context, it would be logical to include a larger sample in future research. Furthermore, a significant correlation between the identified species knowledge and self-assessment could be proven. On the one hand, it can be deduced from this that people are aware of their lack of species knowledge, and the question arises why they may not change this. The reasons for this could be investigated in a future study. In addition, appropriate offers should be made to people to provide

them with opportunities to improve their species knowledge. On the other hand, people with an identified higher level of species knowledge rate themselves more highly. This raises the question of whether this is possibly due to a more frequent experience of nature or more sustainable experiences. This aspect should be focused on in a future study. In addition to the two methods used in this survey, free enumeration and the determination of species recognition based on acoustic sounds of animals represent further possibilities for determining species knowledge, e.g., [11,13]. This shows that there is no standardised method for determining species knowledge. The investigation of those methods and the validation of a standardised construct to analyse species knowledge could enable increased and transparent comparability between different studies. A significant influence of previous participations in a mudflat hiking tour on species knowledge could not be identified. Nevertheless, the importance of primary experience could be demonstrated based on the descriptive results. From these results, it can be concluded that the quality of the primary experience has an influence on the level of species knowledge. This study does not reveal anything about the quality of the mudflat walks or the visits. It is therefore recommended that these aspects be combined for further studies or that factors influencing the quality of species knowledge (e.g., participation in a mudflat walk) be analysed. Accordingly, it makes sense to analyse this study from a qualitative perspective. Therefore, it would be helpful to combine quantitative and qualitative investigations in the form of a mixed-methods approach in future studies. The primary focus of a qualitative approach could be the quality of interactions between people and the ecosystem. Another research aspect for future studies could be the qualitative analysis of the assessment and implementation of educational programmes on site. There is the possibility of planning and implementing programmes together with educational partners, e.g., the Wadden Sea Visitor Centre in Cuxhaven. In this way, various forms of mudflat walks could be tested for their benefits in terms of species knowledge and connectedness to nature. In addition, specific courses to improve species knowledge could be offered in this ecosystem, designed for different levels of knowledge. This study serves as an opportunity to carry out these qualitative analyses and to initiate programmes that promote species knowledge. With regard to the quantitative approach, it can be concluded that an even more extensive sample should be selected in future studies. In addition to a longer on-site survey or the expansion to other local sites at the UNESCO Wadden Sea World Heritage Site, mail surveys could be another way of acquiring a larger sample. In addition, the relevance of connectedness with nature regarding visitors' species knowledge of the Wadden Sea ecosystem was confirmed by the significant result. It can therefore be concluded that experiences of nature are of great relevance to one's own species knowledge.

The survey of visitors revealed the need for further research into species knowledge and the improvement of species knowledge transfer in all areas of education. This requires measures to promote species knowledge in schools, universities, adult education and species experts, on the one hand, and to protect and conserve nature, on the other. The low level of species knowledge described in this study is a development that can be attributed to humans themselves. At the same time, it is up to them to engage more with their environment in the future and to counter the various environmental crises with a higher level of species knowledge as a piece of the puzzle.

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