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The effect of media coverage and perceived local risk on behavioral intentions of humans faced with an invasive species: a case study of the horse chestnut leafminer (*Cameraria ohridella*)

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Devoted to my beloved ones

“Fish may die or human beings; swimming in lakes and rivers may cause illnesses; no more oil may come from the pumps; and average temperatures may rise or fall, but as long as this is not communicated it does not have any effect on society.” (Niklas Luhmann, 1986)

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Table of Contents

Zusammenfassung	xi
Summary	xiii
Chapter 1: Introduction	1
1.1 The field of environmental communication	3
1.2 The concept of impersonal risk	6
1.3 Risk perception and the influence of experience	8
1.4 Optimistic bias	9
1.5 The role of the media in environmental communication	11
1.6 Media coverage of scientific, environmental (risk) issues	14
1.7 Third-person and first-person perception	17
1.8 Overall aims and structure of this thesis.....	18
Chapter 2: Case organism and experimental design	21
2.1 Introduction to case organism.....	21
2.1.1 <i>Cameraria ohridella</i> as case organism?	22
2.1.2 Media reporting about <i>Cameraria</i>	22
2.1.3 Biology	23
2.1.4 Origin	25
2.1.5 Spread of <i>Cameraria</i>	25
2.1.6 Host tree	25
2.1.7 Damage caused by <i>Cameraria</i>	26
2.1.8 Methods to assess damage.....	27
2.1.9 Control measures.....	28
2.2 Experimental design.....	31
2.2.1 Identifying test regions.....	32
2.2.2 Treatments	36
2.2.3 Questionnaires	39
Chapter 3: Manuscript I	45
Chapter 4: Manuscript II	47
Chapter 5: Manuscript III	49
Chapter 6: Manuscript IV	51
Chapter 7: Manuscript V	53
Chapter 8: General Discussion	55
8.1 Summary	56
8.2 Collective Discussion	57

8.2.1 Risk perception.....	57
8.2.2 Behavioral intentions.....	60
8.2.3 Methodological evidence	62
8.3 Thought-provoking impulses	62
8.4 Discussing interdisciplinary research.....	64
8.5 Future research	66
8.6 Conclusion.....	67
References	69
Appendix A: Questionnaires	79

Zusammenfassung

Angesichts der aktuellen Umweltsituation herrscht ein wachsendes Interesse, ein Bewusstsein für Umweltveränderungen beim Menschen zu wecken und umweltfreundliches Verhalten zu fördern. Natur- und Sozialwissenschaftler untersuchen seit Längerem in interdisziplinärer Zusammenarbeit Wahrnehmungen, Einstellungen und Verhaltensweisen der Bevölkerung hinsichtlich Umweltveränderungen, die als unmittelbares Risiko vom Menschen erlebt werden können (“personal risks”), wie z.B. Überschwemmungen oder Erdbeben. Die vorliegende Arbeit erforschte “impersonal risks”, Naturveränderungen, die keine direkte Bedrohung für den Menschen sind, sondern primär ein Risiko für die Natur (z. B. Artensterben). Diese Veränderungen können sich möglicherweise im Laufe der Zeit zu unmittelbaren Risiken für den Menschen entwickeln (z. B. Verlust von Ökosystemdienstleistungen). Um zur Klärung des Zusammenhangs zwischen Medienwirkung, Umweltbeobachtung, individueller Risikowahrnehmung und indizierten Handlungsintentionen bei impersonal risks beizutragen, wurde die invasive Kastanienminiermotte (*Cameraria ohridella*) als Anwendungsbeispiel für ein Feldexperiment ausgewählt. Diese Motte ruft eine auffällige Beschädigung der Blätter des Kastanienbaumes *Aesculus hippocastanum* hervor, die als Umweltveränderung von der Bevölkerung wahrgenommen werden kann, aber keine unmittelbare Gefahr für menschliches Leben darstellt.

Um sowohl den Einfluss der Medienberichterstattung über die Motte auf menschliche Verhaltensintentionen, als auch die Auswirkung des subjektiv wahrgenommenen Risikos auf Verhaltensweisen analysieren zu können, wurde ein experimentelles Design entwickelt, in dem sozial- und naturwissenschaftliche Methoden kombiniert wurden. Umfragen wurden in Regionen durchgeführt, in denen die Beschädigung der Bäume durch die Motte unterschiedlich stark ausgeprägt war.

Im ersten Manuskript wird gezeigt, dass Menschen, die in einem Gebiet mit hohem Mottenbefall leben, eine größere Wahrnehmung für diese Umweltentwicklung haben, was Verhaltensintentionen positiv beeinflusst. Allerdings wird dieser Effekt vollständig durch die persönliche Risikowahrnehmung der Studienteilnehmer mediiert.

Im zweiten Manuskript werden die Auswirkungen von medial vermittelten Informationen auf die Risikowahrnehmung des Rezipienten untersucht. Durch ein experimentelles Treatment (drei schriftliche Artikel, die in der journalistischen

Zusammenfassung

Aufbereitung variieren), steigt die Risikoeinschätzung der Teilnehmer signifikant. Der Grad dieses Anstiegs hat sich als abhängig vom journalistischen Stil erwiesen. Weitere Analyseschritte zeigen, dass die Anfangsrisikoeinschätzung und damit auch die Größe des Medieneinflusses zudem stark abhängig von der bereits vorhandenen individuellen Umweltbeobachtung der Studienteilnehmer sind.

Im dritten Manuskript werden zwei Wahrnehmungsverzerrungen identifiziert und erläutert. Studienteilnehmer sind der Meinung, dass Gebiete, die eine größere Distanz zu ihrem Wohnort besitzen, einem stärkeren Risiko von Mottenbefall ausgesetzt sind als die eigene unmittelbare Nachbarschaft (“optimistic bias”). Außerdem schätzen die Interviewten den Einfluss von medialen Informationen auf sich selbst höher als auf Andere ein (“first-person perception”).

Im vierten Manuskript wird festgestellt, dass Bildungsniveau, Alter und Besitz eines Gartens ökologisches Grundwissen beeinflussen. Ökologisches Wissen hat keinen direkten Effekt auf die hier interessierenden Verhaltensweisen. Grundwissen beeinflusst jedoch das Bedürfnis nach Wissen (“need for cognition”), was eine unmittelbare Wirkung auf Verhaltensintentionen zeigt.

Diese vier Manuskripte beruhen auf repräsentativen Stichproben. Die gleiche Befragung wurde zusätzlich nur mit Studenten durchgeführt, um Antwortverhalten und die Effektstärken von Ergebnissen zwischen den beiden Datensätzen zu vergleichen. Die Ergebnisse in Bezug auf optimistic bias und Wirkung des Treatments waren kongruent. Auffällig in diesem Vergleich war, dass Studenten dieser Studie keine first-person perception haben.

Im Rahmen dieser Projekte ist es gelungen, den aktuellen Wissensstand im Forschungsfeld Umweltkommunikation, bezogen auf impersonal risks, um die vorliegenden Erkenntnisse zu erweitern. Basierend auf den Forschungsergebnissen werden Konsequenzen für erfolgreiche Umweltkommunikation diskutiert.

Summary

Given the current environmental situation, there is a growing interest in how to foster people's awareness for nature changes and promote pro-environmental behavior. Many natural and social scientists have – in an interdisciplinary fashion - started to investigate humans' perceptions, attitude and behavior towards natural hazards, such as flooding or earthquakes, which may be perceived and experienced as an actual personal threat (“personal risks”). This thesis is concerned with another category of environmental risks, the “impersonal risks”. Those risks are defined as a threat to the environment and not as a direct threat for the individual (e.g. loss of species), but with probable direct consequences for the individual in the long run (e.g. loss of ecosystem services). To analyze this category of environmental risk, a case organism, which is defined as impersonal risk was chosen: the invasive moth species *Cameraria ohridella*, which creates damage to the leaves of the cultural important tree *Aesculus hippocastanum*, yet does not threaten human life or well being. This damage is observable by humans as nature change.

An experimental design was created, which combines methods from social and natural sciences to analyze the effects of media coverage, nature change perception, and perceived local risk on people's behavioral intentions. Surveys were conducted in regions that differ in observable nature change evoked by the invasive moth.

In the first manuscript, it is shown that people facing a strong nature change (high infestation levels) show higher extents of nature change perceptions, which affect their behavioral intentions. However, this effect is completely mediated by their personal perception that the moth is a risk.

The second manuscript explores the effects and interrelation of nature change perception and media coverage on risk perception. Through an experimental treatment (three written articles, varying in journalistic style), risk perception of participants increased significantly. Different treatments showed different levels of influence, yet the individual perception that nature is changing is a prior determinant of the level of risk perception and of the extent of media effect.

Distortions in risk perception and perceived media effect were identified in the third manuscript. Participants think that others are at a greater risk of being affected by the invasive leafminer than they themselves (“optimistic bias”) and they show the

Summary

tendency to think that they themselves get influenced more heavily by media coverage than other people (“first-person perception”).

In the fourth manuscript, factors that impact ecological knowledge and its effect on communicative behavior were investigated. Education, age, and garden ownership influence ecological knowledge. Furthermore, prior knowledge did not directly affect communicative behavioral intentions. However, knowledge influences peoples’ need for cognition, which displayed a direct effect on behavior.

The first four manuscripts were building upon representative datasets. Additionally a student survey was conducted and results of response patterns and effect sizes were compared to those derived from the representative sample. The results indicate that the survey based on the student sample reveals similar results compared to the results of a representative sample for some contents (optimistic bias, effect of treatment). However no first-person perception, which was found in the representative sample, was identified in the students’ sample.

Building on comprehensive datasets derived through methods from natural and social sciences, this thesis extends current knowledge in the field of environmental communication through focusing on impersonal risks. Based on the results of the five manuscripts, different approaches for successful environmental communication of impersonal risks are illustrated.

Chapter 1: Introduction

Geologic records show that Earth's systems and life forms have always undergone change (Warner et al., 2012). This fact is neither new nor surprising, as life and Earth's history are in a perpetual process which is commonly called "evolution". Periods of stability and more dynamic periods continually alternate, both in nature and society, which are coevolutionary. Yet human impact, resulting from increasing globalization and population growth and thus the need for humans to expand their ecological footprint, tends to escalate the intensity of natural changes. This will sooner or later have direct consequences for the future of humanity, e.g. biodiversity decline due to habitat destruction and the subsequent fragmentation and deterioration of the remaining habitats are major global risks which will affect humanity in the long run (Callens et al., 2011; Habel, Roedder, Schmitt, & Neve, 2011). Other changes to the natural world such as water scarcity are already becoming major threats to human survival (Heinrichs & Grunenberg, 2009). Ulrich Beck, a sociologist, coined the term "risk society" (*Weltrisikogesellschaft*) to describe humanity's current global condition (Beck, 2007).

A common approach to environmental protection is to create areas where humans are not allowed to interfere. Strategies of "gating" natural areas involve setting land aside and fencing it off for the exclusive purpose of conservation. Local people are often excluded in the process. Such walls constitute a message concerning environmental regulations and human-land interaction (Jurin, Roush, & Danter, 2010). Numerous studies have shown that despite significant conservation efforts, habitat destruction and biodiversity loss have continued at an unprecedented rate (Habel et al., 2015; Pellikka, Lötjönen, Siljander, & Lens, 2009; Teucher et al., 2015). Therefore, the question remains as to how pro-environmental behavior may be supported everywhere (not just in gated areas), thus mitigating the negative effects of human pressure in a sustainable way? The foundation of this thesis is the argumentation for a participatory process in which information about environmental issues is communicated, risk sensitivity is raised and environmentally friendly behavior is promoted. This is a very difficult and complicated task. However, given the current environmental situation, it is clear that future generations of humanity will be threatened if the present generation fails to redirect its priorities soon (Jurin et al., 2010). Despite the slow pace of societal change, some

progress is already noticeable: “green” is “in” in many industrial countries. Environmental messages are being compellingly communicated, and many people have come to accept the need for change (Jurin et al., 2010). Yet we are far from done. Environmental communication scholars need to conduct further research to understand how risk sensitivity and pro-environmental behavior can be successfully and sustainably encouraged. Professionals need to focus on formulating messages based on complex scientific information in a sensible and holistic way. Given the rise of new media this century and the stressful world we live in, there is a lot of noise to distract people from getting important environmental messages and changing their behavior, but this makes it even more imperative for natural and social scientists to work together on effective environmental communication (Jurin et al., 2010).

Who is responsible for this task? Often, the natural and social sciences are considered as unconnected fields of research. In reality, humans and their environment interact; therefore, cooperation between natural and social scientists is greatly needed. Niklas Luhmann, a sociologist, criticized that broader analyses of what can be done to improve the situation of society as a whole have not been made due to the clumsiness of traditional thinking. Social scientists have focused solely on social issues such as poverty, the problems of developing countries, etc. The topic of environmental issues has thus far played no major role, as “the environment” was considered the province of biologists, just as “medicine” was that of doctors (Luhmann, 1995). On the other hand, biologists have similarly limited the scope of their research. While investigating ecological processes, they have largely disregarded humans as a major influencing factor. Luckily, these ways of thinking are vanishing more and more as researchers become aware that such complex issues are better investigated and solved in an interdisciplinary manner. The magnitude of human impact on the planet’s ecological systems is becoming ever more apparent, thus encouraging scientists to study connections between these systems, human health, the economy, social justice and even national security (Lubchenco, 1998). There is a growing realization in both areas of science that new perspectives are needed to understand the implications to society brought by changes to the natural world (Warner et al., 2012), and also to determine how society can adapt to, accelerate or decelerate the pace of environmental changes through individual behavior.

The field of “environmental communication” constitutes a research hub. The very name implies that it is about scientists working together, as “communication” can only be successful if more than one person is involved, just as in scientific research. Scientists

today no longer engage in so-called “science wars”, but rather merge their passion for science. There is a great need for new, fundamental research that can provide policy- and decision-makers with ecological, economical and socially fair and sound solutions. Moreover, collaborative work between social and natural scientists may increase the quality of communication directed towards the public. This would allow the needs and challenges of an integrative policy to be met through a holistic approach.

Motivated by this prospect, the field of environmental communication is the subject of this PhD thesis, which was developed within the framework of a larger project combining social and natural science-based evidence to critically investigate the influence of environmental factors and media coverage on people’s perception of risk and their pro-environmental behavioral intentions.

1.1 The field of environmental communication

In 1969, Clay Schoenfeld first used the term “environmental communication” in the *Journal of Environmental Education*. A wildlife manager and reporter who became a university professor, he defined environmental education as “communication aimed at producing a citizenry that is knowledgeable concerning our environment and its associated problems, aware of how to help to solve these problems and motivated to work toward their solution” (Schoenfeld, 1969). This is still the main interest of environmental scholars.

Between 1969 and 1991 many environmental communication programs started to develop, and first articles and handbooks analyzing and discussing the relationship between humans and the environment were published (Jurin et al., 2010). The authors were of various professions, including biologists, politicians and journalists. Significant historical events for the field of environmental communication included the launching of the first Earth Day in 1970, an article titled “Mass Media and Man’s Relationship to His Environment” by Gerhart Wiebe, published in *Journalism Quarterly* (Wiebe, 1973), and the founding of the United Nations Environment Programme with its main office in Nairobi, Kenya in 1972. Another highlight was the first Conference on Communication and the Environment in 1991. The conference is now held biennially.

What does environmental communication really mean today? An informal definition by Robert Cox sums it up well. Cox defined it as “a study of the ways in which we communicate about the environment, the effects of the communication on our

perceptions of both the environment and ourselves, and therefore on our relationship with the natural world” (Cox, 2012). The aims Cox listed are diverse, ranging from education to consciousness-raising and mobilization. Cox further wrote that the purpose of the field is “to enhance the ability of society to respond appropriately to environmental signals relevant to the well-being of both human communities and natural biological systems” (Cox, 2007, 2012). This is similar to what Schoenfeld said when introducing the term in 1969 (Schoenfeld, 1969). These definitions also form the basis and describe the same intention as both the present PhD thesis and the larger project of which it is a part.

The axioms and foundational concepts of environmental communication were summed up by Richard Jurin, Donny Roush and Jeff Danter (Jurin et al., 2010):

- i) Communication of environmental issues is a human activity. Of course, non-human organisms also communicate, but the deliberateness and richness of message that forms the communication of environmental information is only found among humans;
- ii) “You cannot *not* communicate” (Watzlawick, Beavin, & Jackson, 1969). Pure existence is already communication. Researchers and environmental scholars should be aware that by not actively communicating environmental issues, they may inadvertently deliver a false impression of security or insecurity;
- iii) Understanding is the aim of communication. Communication can only be considered successful if the recipient understands the message correctly. However, it may be difficult to explain complex scientific information, especially when professionals have been working in a specific field for a long time. Knowing one’s audience and having clear communication goals in mind help make communication successful;
- iv) Most of the responsibility for any process of communication rests with the communicator, not the recipient;
- v) Human society depends on nature and the one Earth we have for survival. All people rely on nature in their daily lives, whether for food, shelter, air, or any other necessity derived from the natural environment. Even though most people mainly focus on their own economic situation, they can only work if nature is working;
- vi) Earth has its own messages to share with people. Everyone is capable of listening and understanding them, yet ordinary people often need scientists as “translators”. Therefore, scientists are important conveyors of information from the Earth.

All of the above axioms form a basis for successful environmental communication. Interesting research on improving communication is currently being conducted by scholars from both the environmental natural sciences and the social sciences (Jurin et al., 2010).

An example of environmental communication is the global change documentary “An Inconvenient Truth” by former US Vice President Al Gore. The movie was made out of slides from a campaign Al Gore started in order to educate citizens about global warming. The slides are interwoven with scenes from Al Gore’s life. The movie was very successful (grossing \$50 million at the box office and winning two Academy Awards in 2007). Al Gore gave his presentation more than 1,000 times before the film was made, which together with the movie generated lively discussions about climate change not only at the governmental level, but also in private households and schools.

As the field of environmental communication grows, more environmental information is being offered and consumed by the general public. Jurin et al. conducted a census of the environmental periodicals that appeared from 1969 to 2009, using these numbers as a proxy for the overall volume of environmental communication (Jurin et al., 2010). Using a predefined “Environmental Index”, they showed that environmental communication media steadily increased. Whereas in 1969 only 31 environmental periodicals were being published, by 2009 their number had grown to 1,187. Besides periodicals, the quantity of “scientific” information published by other mass media outlets continues to grow. The word “scientific” is deliberately set in quotation marks here because technology and modern media systems like the Internet make it possible for a lot of information that is scientifically inaccurate to be published. In 1970, the year of the first Earth Day, those celebrating mostly got their information from printed and broadcast news sources: TV, radio, newspapers, magazines and books, in addition to telephone calls, motion pictures, etc. Nowadays, people in developed countries always have digital electronic devices at hand, and many developing countries are catching up. The supply has grown exponentially: In 2016 there were around two billion Internet users (Curran, Fenton, & Freedman, 2016) who could watch YouTube videos about climate change rather than read articles. Furthermore, technology is developing rapidly, offering many different channels. An innovative app that emerged in 2016 illustrates what is possible with modern technology: “Pokémon GO”. At the height of its popularity, this app caused countless people to walk around outdoors to search for imaginary animals and collect them via their cell phone, starting right outside their own front door. This app therefore

fused real life with images processed by the screen of a cell phone. The full potential of such games has not yet been explored, but this example shows how fast technology is developing, motivating (young) people to go outside and creating more research space and options for environmental communication.

1.2 The concept of impersonal risk

Robert Cox (2007) maintained that environmental communication is a “crisis discipline”, tasked with convincing people to reverse or slow down the degradation of the planet, similar to conservation biology, in which natural scientists aim to protect species and ecosystems (Cox, 2007). Environmental communication has clearly become a discipline that deals with environmental risks and crises. To define the term “risk”, Billie Jo Hance, Caron Chess and Peter M. Sandman (Hance, Chess, & Sandman, 1988; Hance, Chess, & Sandman, 1990; Sandman, 1987, 1991) provided the following equation:

$$\text{Risk} = \text{Hazard} + \text{Outrage}$$

In this equation “Hazard” is equal to probability multiplied by consequences. “Hazard” is therefore a term that describes how harmful a risk is likely to be and may be used, for example, to express how harmful a one-meter flood might be for people living in a specific area. “Outrage” denotes a subjective reaction to risk, as it is based on perceptions that may be real or imagined. Indeed, human imagination is experienced as “real”: “We all believe what we want to believe...” (Sydney J. Harris). This explains why purely scientific information (especially if it is complex) might not get processed or acknowledged by the public, and might even be disregarded. When scientists speak of a risk, they stress its likelihood according to statistics and numbers. However, social scientists and environmental scholars have discovered over the past 30 years that if you want people to process and accept scientific information, even when they do not agree with it, you need to provide them with more than numbers. For example, even though people may have received the information that, statistically speaking, a given environmental issue does not actually pose a public risk, they might feel or believe differently. This is one of the main issues that environmental communicators and scientists need to understand (Jurin et al., 2010). While scientists often work with probabilities, aspects of risk that have nothing to do with probability are often more

important to the public, such as the credibility of the communicator or their own prior experience.

Most studies have evaluated “personal risks”, whereby the risk causes direct harm to individuals and thus may be perceived and experienced as an actual personal threat (e.g., diseases like cancer, earthquakes, flooding) (Wahlberg & Sjoberg, 2000). This thesis is concerned with another category of environmental risk: changes to the natural world that do not directly cause harm to people, but that threaten their immediate environment. LeeAnn Kahlor and others introduced the term “impersonal risk” in contrast to “personal risk” (Kahlor, Dunwoody, Griffin, & Neuwirth, 2006). “Impersonal risks” are defined as threats to the environment that do not directly threaten the individual, but will probably have consequences for the individual in the long run, such as overfishing or global warming. There is great interest among scientists, officials, non-governmental agencies and policy makers in learning how to create public awareness of current, impersonal risks that might directly affect people later, possibly with a time lag (Kahlor et al., 2006). From the perspective of natural scientists like biologists, this category of risks and risk research is of great interest because many ongoing changes to the natural world like the loss of biodiversity may currently be categorized as “impersonal risks”.

Additionally, some environmental risks may be defined as either personal or impersonal, depending on the context. For example, climate change can be a personal risk for people living in areas where strong flooding or droughts are already causing damage, while people in many European countries still mostly perceive climate change as an impersonal risk, since their daily lives are not yet affected and climate change is still hardly noticeable there. The definition of a risk as personal or impersonal is further influenced by time effects. If climate change is not yet perceptible as a personal problem for many European people now, it likely will be in the next 50 years (e.g., when food resources are affected). One crucial reason for the common reluctant emotional response to climate change may be related to the viewer’s perceived geographical and temporal distance from climate change (Spence, Poortinga, & Pidgeon, 2012); by the time danger is perceived as being present, it is already causing personal damage. The same is true for the loss of biodiversity. As long as the changing species composition does not affect ecosystem services that sustain human life, it may be defined as an impersonal risk.

Why should we worry about impersonal risks? The tangible effects of many such risks, like the loss of biodiversity, are generally negligible at first. Yet many emerging social, economic, environmental, or physical consequences could be reduced through the

early adoption of risk-reducing behavior or voluntary actions if impersonal risks were to become perceived as personal. For example, in the case of the loss of biodiversity, early conservation of species would prevent loss or changes to species composition, thus averting or reducing negative effects on the services humans need from ecosystems. Early behavioral patterns may therefore serve to increase or decrease later physical risks (Kasperson et al., 1988). In order to enhance the effectiveness of environmental communication, researchers must understand and focus on the concept of impersonal risks. The following sections will elaborate on pertinent research questions.

1.3 Risk perception and the influence of experience

To this day, many believe that educating people will automatically induce pro-environmental behavior (Fliegenschnee & Schelakovsky, 1998). However, research has shown that knowledge alone poorly correlates with pro-environmental behavior (Finger, 1994). Researchers have therefore looked for other explanatory factors. One promising variable is prior experience.

A common adage holds that “experience is the best teacher”. The consequences of risks that can be seen, heard and felt—like a sunburn from overexposure to the sun—create retained impressions which shape individuals’ subsequent behavior, and in their recounting, even that of others (Marx et al., 2007). Various studies on environmental issues use hazards and environmental occurrences with direct consequences or threats to people as case examples, including flooding (Terpstra, Lindell, & Gutteling, 2009) and hurricanes (Sattler, Kaiser, & Hittner, 2000). These studies reveal the relevance of personal experience for individual risk perception and behavioral intentions. In one of the first publications on risk perception, Gilbert F. White found that people’s past experience directly influenced their behavior when they were under threat (White, 1945). This apparently happens because attitudes based on direct experiences are more accessible to memory (Fazio & Zanna, 1981; Regan & Fazio, 1977). In the case of natural hazards, Neil D. Weinstein argued that direct experience provides greater vividness, more rapid recall of relevant information, greater personal involvement, and lower levels of uncertainty in comparison to abstract hazard information (Weinstein, 1989). Encountering dangerous situations triggers emotional reactions which then foster neuroendocrine conditions which enable the storage and retrieval of information about a specific situation. Situations of consequence to an individual can be expected to evoke affective

reactivity (Spear & Riccio, 1994). Individuals who have direct experience of an event like flooding are more likely to be concerned about the issue and are therefore far more motivated to display pro-environmental behavior (Spence, Poortinga, Butler, & Pidgeon, 2011). In a study on air pollution in Great Britain, it was found that people with health problems caused by air pollution showed greater risk perception and were more likely to take action against climate change (Whitmarsh, 2008). In addition, research on flood experience indicates that people with first-hand experience of flooding perceive climate change as a greater risk with less uncertainty, and they show a greater willingness to act, in the given case, to save energy (Spence et al., 2011). This raises the question of people's proximity to a risk source together with the importance of experienced personal damage, or at least the prospect of detrimental changes to the natural world as a near threat.

In summary, most studies on risk perception focus on risks that are personal threats to humans, such as flooding (Terpstra et al., 2009) or hurricanes (Sattler et al., 2000). All such studies reveal the relevance of personal experience and thus the significance of the presence of detrimental changes to the natural world with regard to individual risk perception. An aim of this thesis is to go one step further and investigate the relevance of direct observation of a negative change in nature to individual risk assessment of impersonal risks on the basis of a case example in Germany in which the public's well being is not threatened at all. So far, it has not been determined whether or how the mere perception of such a change might influence people's perception of a truly impersonal risk. This thesis is meant to contribute to research on environmental and risk communication, focusing on impersonal environmental risks, to answer this question: How important is people's mere perception that nature is changing in a way that will not immediately harm them to their perception of individual risk and their consequent behavior?

1.4 Optimistic bias

In terms of risk perception, people often tend to think that other people are at a higher risk than they themselves are. This phenomenon is called "optimistic bias" (Weinstein, 1980). A common example is the risk perception of smokers. A study by Jeffrey Jensen Arnett showed that, in contrast to nonsmokers, adolescent and adult smokers were less likely to believe that they would die from smoking, even if they

expected to smoke for 30 or 40 years (Arnett, 2000). Optimistic bias is therefore the tendency of individuals to have more positive expectations of their own future than that of others (Dohle, 2013). Similar phenomena have been observed in the area of environmental communication, especially in the field of climate change communication. For example, most Americans consider climate change to be a moderate risk that is more likely to impact people and places far distant from them in space and time (Leiserowitz, 2006). Four stakeholder groups connected to the ski industry in Queenstown, New Zealand perceived climate change as a distant and greater threat to other people and places, thus exhibiting “optimistic bias” (Hopkins, 2015).

Similar to its effect on risk perception, prior direct experience is known to have an influence on people’s level of optimistic bias (Burger & Palmer, 1992; Van der Velde, Van der Pligt, & Hooykaas, 1994; Weinstein, 1980). Optimistic bias was present after the 1989 Loma Prieta earthquake, though it only manifested itself three months later (Burger & Palmer, 1992). In other research on earthquakes, it was observed that people who experienced the 1994 Northridge event showed very little optimistic bias immediately following the earthquake, as well as for several months after the disaster. The least optimistic bias was displayed by individuals who experienced greater relative loss in the earthquake (Helweg-Larsen, 1999). A study and a follow-up study on hurricane risk perception and optimistic bias revealed that hurricane risk perception declined two years after major hurricane events, while optimistic bias increased. (Trumbo, Lueck, Marlatt, & Peek, 2011; Trumbo, Meyer, Marlatt, Peek, & Morrissey, 2014). A consistent finding is therefore that prior negative experience is associated with less optimistic bias (Weinstein, 1980). There are several possible reasons for this:

- i) Experience of a negative event may decrease people’s belief that they have control over events compared to those without prior experience;
- ii) Negative events may make it easier to imagine being at risk. The risk may even be overestimated;
- iii) People may believe that if something happened in the past, it could happen again in the future.

No matter which explanation applies, all suggest that prior negative experience affects personal risk estimates, and the extent of their optimistic bias may vary.

In conclusion, this means that it is imperative for research on impersonal risks to determine, whether optimistic bias will appear, how strong it is likely to be, and whether it will be influenced by the proximity of a risk that involves no personal danger.

1.5 The role of the media in environmental communication

The media are “part of the very fabric of culture” (Hepp, Hjarvard, & Lundby, 2010), implying that we perceive great parts of “the world” through the media, which provide information about issues that are not personally experienced by everyone. Hence, the media are a major source of general and scientific information on environmental issues (Dunwoody & Peters, 1992; Schäfer & Schlichting, 2014). Risks are often first heard of and learned about through news media outlets (Vasterman, Yzermans, & Dirkzwager, 2005).

The importance of spreading information about natural changes through communication channels was identified early. As Niklas Luhman stated in 1986, threats to survival only become common knowledge through communication. Luhman wrote, “Fish may die or human beings; swimming in lakes and rivers may cause illnesses; no more oil may come from the pumps; and average temperatures may rise or fall, but as long as this is not communicated it does not have any effect on society.” (Luhmann, 1986). Luhmann meant that purely scientific results about topics such as the loss of species do not represent attempts to solve actual problems or risks, but rather describe abstract phenomena. An environmental phenomenon can only be described as an environmental problem if the results of the data are communicated (interpersonally or via media) to the public and society shows some response (De Haan, 1995; Luhmann, 1995). Since environmental problems are only defined and perceived as such when they are communicated, and this process often depends on information transmitted by the mass media, Luhmann emphasized the importance of the mass media.

A key question for researchers is how information conveyed by the mass media may affect people’s attitudes, perceptions and behavior. This is a question of great urgency, considering many abstract ecological crises of global proportions such as biodiversity loss or climate change, which cannot be perceived by the public directly (Stamm, Clark, & Eblacas, 2000). People are therefore becoming increasingly dependent on publicized evidence. Because information about environmental change and associated risks are mainly communicated to the general public through the mass media (Dunwoody

& Peters, 1992), the media have become a highly relevant platform for public discourse across topics and institutions. The mass media make relevant topics discernible to all members of society (Gerhards & Neidhardt, 1991), and they are able to portray to the general public just how dangerous various risks might be (Jurin et al., 2010). This influences people's attitudes and behavior, as the media provide essential information which citizens may translate into political action (Johnson-Cartee, Graham, & Spake, 1992). On the basis of the information the public receives, individuals discuss political issues, analyze the material presented and eventually form their own opinions. In addition, the mass media have the democratic function of scrutinizing and monitoring political decisions, taking into account societal preferences and wishes (Stober, 1992). The duty of the mass media in a democratic society is to inform the public about current events and topics (Blöbaum, Görke, & Wied, 2004). This is to broaden the recipients' knowledge of current matters and to create a more complex and comprehensive overall picture.

“The press may not be successful much of the time in telling the people what to think, but it is stunningly successful in telling its readers what to think about” (Cohen, 1963). This sentence formed the basis of Bernard C. Cohen's agenda-setting theory, which was further developed by Maxwell McCombs und Donald Shaw and is still today one of the most important tenets of communication science (Brosius, 1994; Eichhorn, 2005; McCombs & Shaw, 1972; McCombs, Einsiedel, & Weaver, 1991). This concept has been analyzed now for decades, and the literature shows that the quantity of environmental reporting is but one of many influencing factors (De Haan, 1995). Another interesting question for environmental communication scholar is how the quality of media coverage might influence people's perceptions and behavior.

But how does it come that the mass media offer different levels of quality? Even though the main purpose of the mass media should be to inform, Jurin and colleagues determined—though it may seem cynical—that the main goal of the media is to make money. This is mostly done through advertising, whether on TV or online (Jurin et al., 2010). However, the researchers also contended that the general focus of the media was still information, persuasion and entertainment. Consequently, the media do not publish information on environmental issues just to create awareness and disseminate knowledge; rather, the media are a business in which different actors compete. News media transmit information about current events to the general public. While news outlets have the highest claim to accurate and fair reporting, they may exert influence through how they

process and prioritize information. Social, political, economic, ethical and religious topics are interconnected. Journalists therefore act as “gatekeepers”, as they control much of what we read and see. Jurin referred to media news coverage as a net in which specific big stories get caught. Because each news outlet only has limited space, complex topics, especially environmental or scientific ones, often reach the audience in a distorted, sensationalized, oversimplified or inaccurate manner.

Qualitative aspects such as trust and credibility have been identified as influencing factors (Slovic, 1993; Trumbo & McComas, 2003). Referencing reliable experts may serve to reinforce the impression of seriousness and, indirectly, the perceived subjectivity of news reports (Weingart, Engels, & Pansegrau, 2007). Furthermore, research shows that uncertainty can enhance message effects (Rabinovich & Morton, 2012). While many such aspects have been investigated, little is known about how environmental news features are used as a risk-communication tool (Wakefield & Elliott, 2003). This dissertation will analyze how and whether different styles of written articles that combine many varying qualitative elements, such as complexity, uncertainty or credibility, could be better tools than others. These results may have practical implications for researchers, journalists and environmental policy makers, as the print media are often used—either passively or actively—as a risk-communication tool (Wakefield & Elliott, 2003).

With regard to communicating impersonal risks, it has been shown that the media hardly influence people’s perception of personal risks, as they are usually discussed via interpersonal communication (Wahlberg & Sjoberg, 2000). Research is needed to determine how the style of reporting on environmental changes may change people’s perception of impersonal risks. A question that interests media-effect researchers is whether there is any correlation between the representation of risks by the media and the audience’s independent perception of subjective and environmental risks. Based on cultivation theory, they look for a “double-dose effect” (Gerbner, Gross, Morgan, Signorielli, & Shanahan, 2002) in risk communication. The cultivation approach holds that people’s beliefs about societal reality are influenced by mass media coverage (Gerbner et al., 2002). The double-dose effect can occur when there is congruence between a person’s subjective perception and opinion about a situation and the way the media covers it. In such a case, a person’s subjective opinion might be enhanced by media reporting. Transferring this approach to risk communication means that people’s subjective risk perception could be boosted if they found recognizable portrayals of changes to the natural world and the associated risks in media reports.

1.6 Media coverage of scientific, environmental (risk) issues

How do the media currently report on scientific findings about environmental issues? What kind of risk information do the mass media transport? There are no proven rules for journalists or media outlets guiding environmental science coverage. For other topics, such as politics, local events, the economy, culture and sports, reporting standards have become established over the past 100 years, influenced by the respective stakeholders and content patterns. For the relatively new topic of environmental science, reporting standards are still emerging. Now that many issues concerning the risks and advantages of scientific progress are reaching the broad public, journalists and the mass media are finding it challenging to communicate information about the life sciences in a qualified way (Blöbaum et al., 2004). In the absence of proven journalistic rules, many content analyses have been conducted to investigate very different theories and hypotheses within the field of risk research.

One important question is whether environmental reporting is balanced or whether media coverage shows a strong bias (Wahlberg & Sjöberg, 2000). In order to carry out “objective reporting”, the journalistic norm of “balanced reporting” is considered a vital tool which provides “both sides in any significant dispute with roughly equal attention” (Entman, 1989). In the literature it is often proclaimed that the media exaggerate some risks while ignoring other benefits (Slovic, 1986), due to journalistic sensationalism. However, various content analyses have found news reports on potentially risky developments such as genetic engineering and nanotechnology to be balanced. Like many other changes to the environment, genetic engineering is not perceptible to the public. Media coverage therefore seems to be shaping public reception of this new technology (Görke, Kohring, & Ruhrmann, 2000). Several German newspapers published between 1973 and 1996 were analyzed to investigate how their reporting about genetic engineering developed over the years and whether the topic was viewed from different perspectives (Görke et al., 2000). The authors identified three stages of reporting: The beginning phase of public debate (1973–1984) was dominated by great euphoria for advancements in research, and only a few newspapers reported about the risks. During the second, or “regulation” phase (1985–1991), German opinion-leader institutions paid greater attention to this field of research, and the discussion of its risks and benefits became more political. In the subsequent phase (1992–1996), called the “globalization” phase, the relevance of globalization for the orientation of genetic engineering was

pointed out, and the stakeholder “industry” accordingly received more attention. The perspective of “progress” dominated all three phases. These results are interesting as they show that the media did not just report negatively about the risks of genetic engineering, as is often claimed, but that the leading German press outlets reported with great objectivity. Balanced coverage was also found for the topic of nanotechnology (Haslinger, Hocke, & Hauser, 2014; Kohring, Marcinkowski, Donk, Metag, & Friedemann, 2011). The analyzed articles showed that the benefits of nanotechnology were reported more than the risks, thus debunking many stakeholders’ fear that newspaper coverage emphasized the risks. Balance reporting was also found for the topic of anthropogenic climate change. Over a 15-year period, a majority (52.7%) of the leading news articles contained balanced coverage, giving roughly equal attention to two different perspectives: that humans were contributing to global warming versus the claim that climate change was exclusively caused by natural fluctuations (Boykoff & Boykoff, 2004). However, “balanced” coverage often diverges from current scientific discourse. In the US, balanced reporting on anthropogenic climate change was shown to be significantly different from the conclusions of the IPCC (Intergovernmental Panel on Climate Change), and it perpetrated an informational bias (Boykoff & Boykoff, 2007). The US mass media allowed a small group of climate-change deniers to receive the same amount of attention as top climate scientists.

Content analysis has also indicated that reporting might depend on the news outlets’ geographical distance to risks or to events that occur. The coverage of anthropogenic climate change was analyzed in newspapers in the United States and the United Kingdom between 2003 and 2006 by Maxwell T. Boykoff (Boykoff, 2007). The researcher found a steady increase in reporting. In the UK, the first big spike took place in June and July 2005, during the G8 summit in Gleneagles, Scotland and when greenhouse gas emissions from air travel came under intense scrutiny. The second big spike occurred between September and November 2006, and may be connected to several key events: Al Gore’s film “An Inconvenient Truth” was released; Britain’s Royal Society issued an open letter to Esso, calling on the oil corporation to stop funding climate change denial; Richard Branson, a highly successful British entrepreneur, made a donation of three billion dollars to renewable energy initiatives and biofuel research; the “Stern Review on the Economics of Climate Change” was released by the government of the UK, and the United Nations Climate Change Conference (COP 12) took place in Nairobi, Kenya. Similar coverage spikes related to specific events were also found for media coverage in

the US (Boykoff, 2007) and in several Spanish newspapers during the period from 2000–2010 (Lopera & Moreno, 2014). Interestingly, after 2007 interest waned in Spain until 2010, which may have been due to greater public interest in other social and economic crises. Analyses of news coverage of avian flu in Hong Kong and in the US have shown that geographical distance to the source of the problem influenced the angle of news reports, e.g., the dimension of dreadfulness was emphasized more in the *New York Times* than in Hong Kong newspapers (Fung, Namkoong, & Brossard, 2011). Distant risk can be sensationalized by using loaded words and by prominently placing news stories. The *New York Times* compared the risk of avian flu in the United States to the risk in other infected areas, and its reporters' use of uncertainty was significantly greater than that by journalists in Hong Kong, which may have served to sensationalize the potentially catastrophic dimensions of the disease (Fung et al., 2011).

News reports frequently fail to put events into a proper context or perspective and do not explain technical terms and statistics (Wahlberg & Sjoberg, 2000). The public is then left to devise its own risk-reduction measures. Climate science has often been portrayed by the media as a controversial and uncertain science (Lopera & Moreno, 2014). This propagation of scientific uncertainty about climate change is very problematic, as it may be used as an excuse to delay political decision-making, even though behavioral changes are urgently needed. Furthermore, risk coverage that contains qualitative rather than quantitative figures or the use of words like “rising” or “rare” rather than clear numbers is less precise and may sway readers differently (Bohlin & Höst, 2014). While it seems understandable that different risks are reported on in different ways, communication researchers stress the importance of direct and clearly understandable hazard information.

In short, media coverage of scientific, environmental issues matters. News reports about risks and benefits are essential to forming public opinion, thus shaping a terrain in which people may be galvanized into action, or, on the contrary, resigned to passivity (Bord, O'Connor, & Fisher, 2000). Information is transmitted in different ways (e.g., balanced vs. biased reporting, reporters' usage of uncertainty, complexity and language) and also depends on external factors such as geographical distance and current events. These differences may influence public perception and consequently people's behavior. Therefore, more research is urgently needed on how these combined aspects potentially influence social acceptance, risk perception and pro-environmental behavior (Maesele, Deneckere, Panis, & Paulussen, 2015).

1.7 Third-person and first-person perception

Aside from the actual effect of media reports, people may hold different beliefs about how the media influence specific groups. Their perception might not conform to reality, but might rather be a distorted perception of media influence, similar to optimistic bias, described above. Third-person perception (TPP) means that people perceive the mass media to have a greater influence on others than on themselves. This perceived difference between oneself and others is the first part of the third-person effect (TPE), which was first described by W. Phillips Davison, a sociologist, in 1983. TPE consists of two parts: a perceptual component (TPP) and a behavioral component, which means that people's perceptions of the media impact their attitudes and behaviors (Tsfati, Cohen, & Gunther, 2011). Third-person perception does not refer to the actual impact of the media, but is instead a perceptual phenomenon. The most discussed possible reasons for the appearance of third-person perception are as follows:

- i) The perceptions in question are correct, which may well be the case for some individuals, but is not logically possible for the entire general public (Perloff, 2009)
- ii) People overestimate the influence of the media on other people (Davison, 1983)
- iii) People underestimate the influence of the media on themselves (Davison, 1983)

Several studies have shown that TPP may disappear or even turn into first-person perception (FPP), the opposite of the more well-known third-person perception (TPP), if the news content is positively framed or aligns with the beliefs of the recipients (Gunther & Mundy, 1993). This means that recipients are then likely to believe that the mass media have a greater influence on themselves than they have on others (Cohen & Davis, 1991). With regard to environmental risks, FPP was demonstrated in the context of showing the climate change movie "An Inconvenient Truth" (Lin, 2013). Sue-Jen Lin argues that people tend to overestimate the influence of negative news on others, but conversely overestimate the influence of positive news on themselves. These findings are highly interesting: Information on climate change from the movie was apparently received as positive and socially desirable input, thereby leading to FPP. The question for the present work is whether the same effect can be achieved with information about other changes to

the natural world and especially news reports about other environmental, impersonal risks, which are already perceptible, but don't cause harm to people?

1.8 Overall aims and structure of this thesis

This thesis aims to bring together the natural and social sciences within the framework of a study analyzing the effect on society of media coverage and an observable, impersonal change to the natural environment in Germany. The findings should contribute to a better understanding of human environmental attitudes, perceptions and behavior as well as expand knowledge about successful environmental communication.

Following this general introduction (chapter 1), a summary of the case organism (the invasive horse chestnut leafminer - *Cameraria ohridella*), chosen as impersonal risk, is given (chapter 2.1). The methods and pre-tests used for this work will be explained in chapter 2.2.

In chapter 3, findings from the current literature related to identifying how people's perception of a current change to the natural environment may alter their risk perception and environmental behavior within the context of impersonal risk will be discussed. Previous research has shown that prior personal experience of certain risks, e.g., cancer or damage due to flooding, elevates people's risk perception. Survey respondents thus affected indicated a greater intention to behave in a pro-environmental manner. However, research on this topic has thus far mostly been framed within the context of personal risks, whereby prior experience was mostly defined as damage or loss. Thus the question for this work (and the title of chapter 3) is: "*When do People take Action? The Importance of People's Observation that Nature is changing for Pro-Environmental Behavior within the Field of Impersonal, Environmental Risk*". The results should serve to enhance understanding of how important the mere perception of an environmental change is for pro-environmental behavior and thus how to communicate environmental issues in ways that foster the adoption of pro-environmental behavior.

Chapter 4 focuses on the "*Effects of Nature Change Perception and Media Reporting on Impersonal Risk Perception*". A lot of research has been done to identify the effects of the quantity of media coverage. It is also highly important to analyze how the same topic, presented in various journalistic styles and thus with different qualitative elements (such as complexity and fragility of content), may impact risk perception, as the

literature suggests that qualitative variables should not be underestimated. Furthermore, the relationship and interconnectivity between the effects of media coverage and the observation that nature is changing will be analyzed for their influence on risk perception. The results presented here will show how different journalistic styles of written articles might help to make the communication of impersonal environmental changes more effective for a broad audience.

Chapter 5 deals with “*Analyzing the Existence and Relation of Optimistic Bias and First-Person Perception for an Impersonal Environmental Change*”. Here potential distortions in perception are investigated in light of theoretical concepts about optimistic bias and first-person perception. The question is whether the public is more likely to be optimistic about a risk (optimistic bias), in this case an invasive moth species. Further it is analyzed whether media are perceived to influence oneself more than other social groups, leading to a first-person perception. In addition, it is evaluated how distortions are influenced by the proximity of an impersonal risk (the infestation by the moth) and by different styles of written articles. Investigating distortions of perceptions may help to explain why individuals perceive and behave in their environment in specific ways.

In chapter 6, “*Factors Influencing Ecological Knowledge and its Effect on Information Processing and Communicative Behavior*” the goal is to understand how the level of people’s basic ecological knowledge may influence the way environmental news are processed and translated into pro-environmental behavior. Even though many research projects have shown that environmental knowledge is only one of many variables that explain pro-environmental behavior, the breadth and level of previously acquired knowledge were shown to have an indirect impact. The intention here is to analyze how socio-demographic factors like education, age or garden ownership influence ecological knowledge and how this is connected to behavioral intentions concerning the leafminer as an impersonal risk.

The results from chapters 3–6 all rely on data derived from a representative sample of survey respondents in Germany. However, the social sciences are often decried as the “sciences of sophomores”, as they commonly use student samples to test their hypotheses. This practice may lead to biased results due to the participants’ specific level of education, their unfinished personalities and the limited age distribution. In the last chapter of this thesis (chapter 7), “*Comparing the Validity of a Representative versus Student Sample in Environmental, Impersonal Risk Research*”, research results on optimistic bias, FPP and the influence of different styles of written articles on risk

Chapter 1: Introduction

perception derived from the dataset using participants of a representative sample are compared to results from a student sample. These investigations might help clarify whether student samples may be used in impersonal risk research, or whether there are strong differences depending on the sample. The results might be very useful for the methodology and sample selection in upcoming environmental communication studies.

Chapter 8 contains a discussion and summary of the results of this work. This chapter concludes with insights and thoughts from personal discussions with participants, self-reflection on interdisciplinary research and future research ideas.

Chapter 2: Case organism and experimental design

2.1 Introduction to case organism

Increasing attention is paid in recent years to the problem of invasive species and their globally rising effect on biodiversity, ecosystems, and public health (Doorduyn & Vrieling, 2011). A commonly used definition for invasive species was given by the IUCN (International Union for Conservation of Nature) in 2000: “Invasive species means an alien species which becomes established in natural or semi-natural ecosystems or habitat, is an agent of change, and threatens native biological diversity” (IUCN, 2000). In other words, invasive species are species that become dominant out of their native range and cause harm to the ecosystems they invade (Crawley et al., 1986; Keane & Crawley, 2002). Thus those invasive species are no longer under human control. They go beyond their “normal” boundaries, and cause environmental damage (Shine, Williams, & Gündling, 2000). Alien species may start competing with native species and: “this can cause the extinction of unique variants or races, resulting in an irreparable loss of genetic diversity. At the global level, alien invasive species are now considered the second cause of biodiversity loss after direct habitat destruction” (Shine et al., 2000). Besides the ecological damage, their impacts can involve significant harm on economic, social, and health level. Recent assessment calculates the annual loss by alien invasive species of USD 336 billion in six countries: United States USD 137 billion, South Africa USD 7 billion, United Kingdom USD 12 billion, Brazil USD 50 billion, and India USD 117 billion (Pimentel, Lach, Zúñiga, & Morrison, 2000). The major driver for unintentional introduction is globalization. The four “Ts” (Trade, Transport, Travel and Tourism) have contributed to a sharp increase in unintended invasion.

Our case organism chosen as an example for an impersonal, environmental risk is the invasive horse chestnut leafminer *Cameraria ohridella*. This species is a member of the lepidopteran family Gracillariidae and was first mentioned by Simova-Tosic and Filev in Macedonia in 1985 as an unknown pest attacking horse chestnut trees (Simova-Timosic & Filev, 1985). It was then described by Deschka & Dimic (1986) as a new species of the genus *Cameraria* (Deschka & Dimic, 1986). It is since then characterized as an invasive alien causing major damage to the leaves of the white-flowering horse chestnut tree *Aesculus hippocastanum*.

The following pages provide a summary of the scientific knowledge about the horse chestnut leafminer.

2.1.1 *Cameraria ohridella* as case organism?

Invasive species are often named as an example of impersonal risks, as they may cause damage to the environment, but do not (yet) threaten the public directly. Many of the invasive species are not perceived actively by the public and citizens are therefore not aware of the ecological consequences. Yet over time, the negative effects of invasive species will also become an issue for the general public, e.g. loss of biodiversity and ecosystem functions will threaten livelihoods. The early adaptation of humans' environmental behavior (e.g. getting involved in control measures) might help to limit the negative consequences.

The horse chestnut leafminer *Cameraria ohridella* is an ideal case organism to investigate specific research desiderata for various reasons:

- i) The damage of *C. ohridella* is directly observable in real nature, yet it is (not yet) a personal threat for the public. This is of high importance in order to investigate the influence of nature change perception on risk perception and pro-environmental behavior for impersonal risks;
- ii) The horse chestnut leafminer creates a damage which varies within regions in Germany. Therefore the degree of perceived infestation may vary between different groups of participants;
- iii) Behavioral change can be analyzed as certain measurements can be undertaken by anyone willing to apply those;
- iv) Sufficient natural scientific knowledge is present in science in order to create reasonable, comprehensible variations of media articles, which will be used as "treatments" (see chapter 2.2.2) to investigate the relationship between risk perception, nature change perception, information given by media, and adaptation of individual behavior.

2.1.2 Media reporting about *Cameraria*

The horse chestnut leafminer gained fast attention in mass media. The infestation through *Cameraria* was and still is present in the German newspapers. Since 1997, newspapers reported every summer about the early defoliation of trees. Media focused on reporting about this pest species with news such as "Horse chestnut trees in our beer gardens in danger" (Heitland, Kopelke, & Freise, 2003). In a bachelor thesis Mosses investigated media coverage about the horse chestnut leafminer, as an example of invasive species, in German newspapers (Mosses, 2012). Solitary with the help of the Google search function, 1.200 newspaper articles from German- language mass media were collected between 1997

and 2012. Mosses analyzed newspaper coverage within those years. In this time period the topic was constantly in the news with new insights and problems. At the very beginning journalists and scientists had only little knowledge about *C. ohridella*, and newspaper described horrifying scenarios due to the invasion of the moth. The intention was to raise public awareness for this issue (Glathe, 2010). In general Mosses found that the media reported more often about observable damage, host trees and control measures rather than about the natural lifecycle or the scientific discussion of the origin of *Cameraria ohridella*. On average, scientific information was used correctly, with small shortcomings when defining the correct host tree (WHITE flowering horse chestnut tree) and using major scientific incorrect or insufficient information on control measures. Further Mosses showed that the number of articles increased over time, yet the focus changed. Between 1997 and 2002, *C. ohridella* was mostly the main topic of the articles. Starting from 2003, increasing numbers of articles showed a main focus of reporting about the overall problem of invasive species and solely pointed to the issue of the chestnut leafminer.

2.1.3 Biology

The adults of *Cameraria ohridella* are approximately 5 mm long with metallic red or ochre brown fore-wings, which measure up to a length of 3.5 mm. *C. ohridella* can complete three to five generations per year. In Bavaria (Germany) mostly three, sometimes four generations were observed (Freise & Heitland, 2004). Female deposit their eggs, which are around 0.2-0.3 mm long and oval, on the upper part of the epidermis of the horse-chestnut leaves. When hatching, the larvae enter the leaf directly. Each generation of *C. ohridella* contains four to five mining/feeding (L1-L4/L5) and two spinning/non feeding larval instars (S1-S2). The feeding larvae consume the palisade parenchyma. Two different types of pupae were observed:

- i) pupae with distinct cocoon, and
- ii) pupae with only little or no cocoon at all.

The first larval instars (first generation) hatch one to three weeks after oviposition. The development from egg to pupae in Bavaria lasts between 49 to 63 days, which is depending on weather conditions, such as temperature.

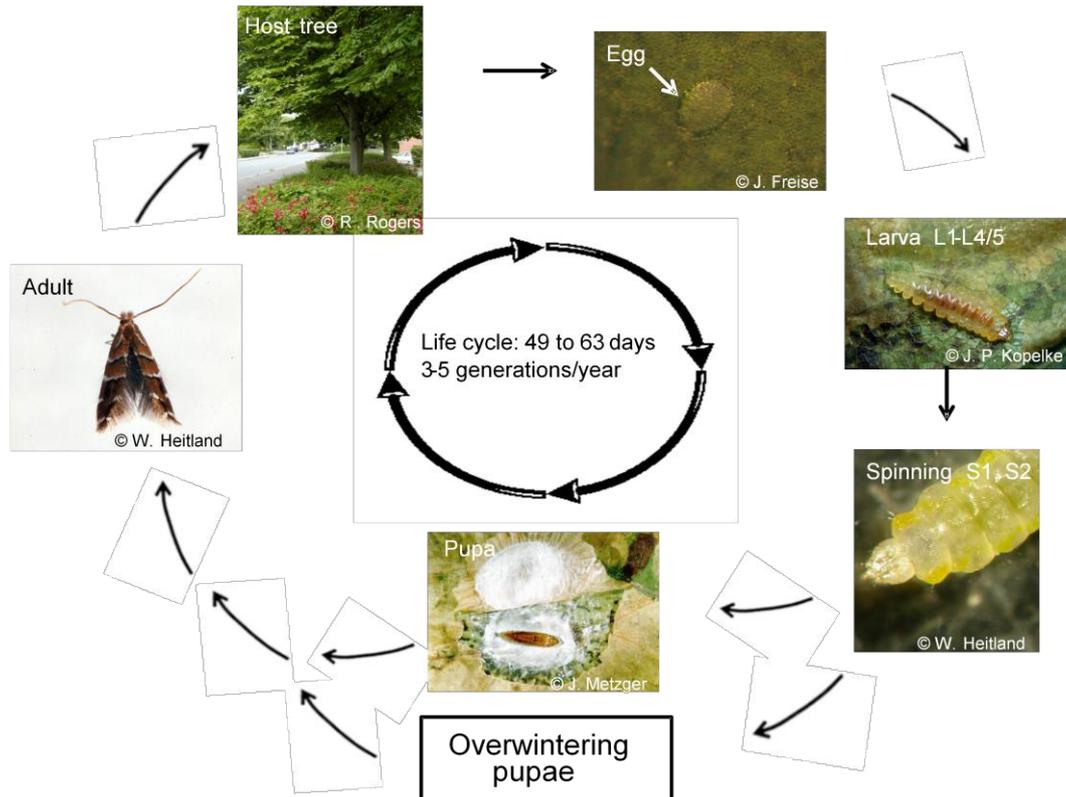


Fig. 1: Life cycle of *Cameraria ohridella* (layout by Péré, 2009 - heavily changed)

In late autumn, mostly the pupae with cocoons hibernate within the foliage on the ground, the pupae with little or no cocoon mostly complete their life-cycle (Freise & Heitland, 2004). It was observed that by the beginning of the season, pupae without cocoon exceed pupae with cocoon, while by the end of the season, the proportion of pupae with cocoons reaches over 95%. In each generation, a certain proportion of pupae diapauses and emerges only the following spring. Therefore it is hardly possible to control *C. ohridella* by food shortage evoked through high population densities, as pupae just enter the diapauses.

Copulation takes place on the tree trunk and the lower branches of the horse chestnut trees (Grabenweger, 2003). Rainfall during the flight period of *Cameraria* can have a negative impact on populations. If the rainfall occurs between the generations, when most individuals are developing inside the leaves, the negative effect is smaller (Gilbert et al., 2005).

There is a linear relationship between the temperature and the rate of egg development. Eggs need at least 4.8°C in order to develop, while larvae do need a threshold of 10.6°C. Hibernating pupae can endure -20 °C, sometimes even -28°C (Freise & Heitland, 2004).

2.1.4 Origin

The interrogative on the origin of *Cameraria ohridella* is not yet resolved completely. Different authors propose different theories, which are listed within this chapter. Deschka and Dimic (1986) suggested that *C. ohridella* survived the glacial tertiary cooling together with its host plant in relict areas in the Balkans. Other researchers argued that *C. ohridella*'s origin is in the Balkans, but that a host shift took place from maples (*Acer sp.*) to horse chestnut trees (Hellrigl & Ambrosi, 2000). Southeastern Asia as origin was put up for discussion as well (Grabenweger & Grill, 2000). However the origin of *C. ohridella* was also investigated with the help of herbarium collections and a Balkan origin, based on amplified nuclear DNA and mitochondrial DNA barcode fragments from larvae pressed within leaves of herbarium samples collected as early as 1879, was concluded (Lees et al., 2011).

2.1.5 Spread of *Cameraria*

During the last 30 years, *Cameraria ohridella* invaded most of Central and Western Europe. The presence of the species was first reported in highly populated areas - mostly cities - before colonizing the countryside (Gilbert, Gregoire, Freise, & Heitland, 2004). One logical explanation is that *Cameraria* is transported human-related (by cars or public transportation systems) and therefore often first arriving in higher populated cities. Another dispersal possibility is the distribution by wind ("air plankton"). There is high evidence for both theories, in which wind or human-related transportation can cause the dispersal (Gilbert et al., 2005). *C. ohridella* is often first found around parking areas or train stations, indicating accuracy of the human-related hypothesis. On the other hand, *Cameraria* is found on single trees far away from infrastructure or roads, arguing for the wind hypothesis.

Augustin et al. monitored the spread of the moth during the period 2001-2003 in France by observing the damage caused by the invasive pest species and establishing pheromone traps (Augustin, Guichard, Svatoš, & Gilbert, 2004). During this period, the spread rate ranged from 17 to 37.9 km/yr (Gilbert et al., 2004).

2.1.6 Host tree

In order to find the specific host plant range for *Cameraria ohridella*, different host plant specificity tests were made (Freise, Heitland, & Sturm, 2003). On 21 of the 36 tested *Aesculus* tree species, the moth was able to complete its life cycle. A full development was also observed on *Acer pseudoplatanus* and *A. platanoides*, if pest pressure is high (Freise et al., 2003). However most larvae die during oviposition (Skuhravy, 1998). Nevertheless in

Europe mostly the white flowering horse chestnut tree is attacked (*Aesculus hippocastanum*). Often chemical agents in the leaves of other tree species may be the reasons for the repellent effect. *Aesculus pavia* L. HBT genotype, characterized by red flowers, showed an atypical resistance towards this pest (Ferracini, Curir, Dolci, Lanzotti, & Alma, 2010).

Horse chestnut trees (*Aesculus hippocastanum*) were introduced into Central and Western Europe from Southeastern Europe. Only a few natural stands still exist. This tree



species was introduced by the Austrian botanist Clustus (1526-1609) to the court of Vienna, as an ornamental tree for parks and gardens. This tree enjoyed quickly high popularity (Heitland et al., 2003). Today it can be found in beer gardens, parks, cemeteries, train stations and often in pedestrian areas or around governmental buildings. For people in Europe the horse chestnut tree has become an ornamental tree and is indispensable. Not only adults enjoy this tree, also children enjoy playing with the fruits in autumn.

Fig. 2: Typical appearance of white flowering horse chestnut trees in Germany. © Rogers

2.1.7 Damage caused by *Cameraria*

Cameraria ohridella is causing observable damage to the leaves of white flowering horse chestnut trees, resulting in early brown coloring of leaves and leaf loss already by midsummer (Fig. 3) (Pschorn-Walcher, 1994).



Fig. 3: Not infested white flowering horse chestnut tree *Aesculus hippocastanum* (left) and observable damage of *C. ohridella* on *Aesculus hippocastanum* (right) in 2014 in Germany.

© Rogers

The damage caused by *C. ohridella* is mostly esthetic. However, various studies have investigated effects on growth, water uptake and other parameters. Results were that the weight of seeds and fruits was reduced when the tree was highly infested, but even older trees are able to endure high infestation rates over a longer period of time (Salleo et al., 2003; Thalmann, Freise, Heitland, & Bacher, 2003). Yet, the number of seeds per fruit, the number of fruits per inflorescence and the number of inflorescence did not change due to the infestation of *Cameraria*. The researcher concluded that *Cameraria* affects the seed quality, but not the quantity. Over a longer period of time, the smaller seed weight may have an impact on the persistence of *A. hippocastanum* (Thalmann et al., 2003).

The impact of *C. ohridella* on wood production was tested in Northeastern Italy by Salleo et al. (2003). The researchers found, that infested trees produced even more wood per year than control groups, as they had a bigger amount of false rings with wider xylem conduits and with higher conductive area on theoretical flow. They concluded that *A. hippocastanum* increases its hydraulic efficiency of the wood to compensate the reduced leaf lifespan and ameliorate water and nutrients in leaves between spring and mid-summer (Salleo et al., 2003). Raimondo et al. (2003) conducted experiments on mature leaves of two 49-year old *A. hippocastanum* trees during massive infestation by the second generation of *C. ohridella*. Photosynthesis loss was in relation to loss of green area 1:1, meaning that the loss of photosynthetic activity did not range further than the loss of green area (Raimondo, Ghirardelli, Nardini, & Salleo, 2003).

2.1.8 Methods to assess damage

In order to estimate the population size of *C. ohridella*, there are various qualitative and quantitative measures. Quantitative methods provide precise results, but are extremely time-consuming, e.g. digital image processing of single leaves with damage. Qualitative or semi-quantitative measures are faster and still reliable (Gilbert & Gregoire, 2003). Digital image processing of leaf damage was compared to visual assessments using a key of seven infestation levels (0 = 0%; 1 = 0–2%; 2 = 2–5%; 3 = 5–10%; 4 = 10–25%; 5 = 25–50%; 6 = 50–75%; 7 = 75–100%). It was shown that the visual assessment of leaf damage was closely related to the “real” number of mines (Gilbert & Gregoire, 2003). Thus, visual assessment is a fast and effective method, which can be directly used in field studies.

2.1.9 Control measures

Due to their mass appearance, measures against *Cameraria* were investigated quite early. It was detected that this moth is very resistant to various controlling measures (Arnold & Cetin, 2002).

Biological control

The initial success of invasive species towards parasitoids and predators is explained by the enemy release hypothesis. It explains that while being introduced into a new environment, native natural enemies are yet scarce and poorly adapted. Over the years, however, parasitoid richness may increase either because the invading host continuously encounters new parasitoid species while spreading (geographic spread-hypothesis) or because local parasitoids need time to adapt to the new host (adjustment-hypothesis) (Grabenweger et al., 2010). Researcher found that for *C. ohridella* overall parasitism rate increases as a function of host residence time. However, parasitism rates are still rather low (usually lower than 10 %) (Freise & Heitland, 2001; Freise, Heitland, & Tosevski, 2002; Grabenweger & Lethmayer, 1999; Zwölfer & Pschorn-Walcher, 1968). Those studies show that parasitism complexes include mostly generalists and polyphagous parasitoid species.

In addition to parasitoids, several birds species have been observed to prey on *C. ohridella* (Grabenweger et al., 2005). Out of the 20 bird species present in a chestnut tree in Bern only blue tits (*Parus caeruleus*), great tits (*Parus major*) and marsh tits (*Parus palustris*) preyed on the mines of *C. ohridella*. Predation rates of birds ranged from 2-4% of leafminer population. For many other insect predators (mites, bushcrickets, etc.), predation rates were even lower (Grabenweger et al., 2005).

These results show that using artificial increase of predators or parasitoids as biological control (e.g. increase tit numbers through higher numbers of nesting boxes in trees) might help to reduce pest densities, yet will not really impact the observable level of damage as rates of parasitism and predation are rather small and native natural enemies are yet scarce and poorly adapted.



Fig. 4: Tit searching for larvae on leaves of infested horse chestnut tree (left) and nesting box (right).

Chemical control

Research on *Cameraria ohridella* females revealed that calling behaviors through sex pheromones are performed to attract males (Francke et al., 2002; Svatoš et al., 1999). Samples prepared with these pheromones were highly attractive in field tests and are proved to be effective to monitor flight activities and population dynamics (Kalinova et al., 2003; Svatoš, Kalinova, & Hrdý, 2009). Pheromone based monitoring systems nevertheless are limited in their suitability, as their sticky surfaces may be full with moths after short time. Further, pheromones may be combined with an insecticide and thus used as “attract & kill” technique (Svatoš et al., 2009). But as with the monitoring system, the suitability on large scale is low, as systems need to be emptied and refilled constantly.

Chemical agents, formerly known as “insecticides”, can be sprayed onto each tree individually. Lethmayer (2005) summarized the possible control methods. For chemical control she explains that in 1995 first chemical control strategies were tested with insect growth regulators. The evaluations showed that best results were obtained with “Alsystin Bayer” and “Dimilin”, where 98% - 100% of the larvae were killed. Yet spraying every single tree is very time-consuming and thus tree-injections were expected to be a promising compromise. However, the evaluation of tree-injections showed that only an irregular dispersion of the insecticide within the tree can be achieved, so that high efficacy was only reached in some parts of the tree. However, a duration of efficacy of more than two years could be observed on respective branches (Lethmayer, 2005).

Nevertheless it is known that chemical agents do affect the environment negatively (Cowan & Gunby, 1996), especially spraying techniques transmit agents onto other ecosystems further away.

Cultural control

Foliage removal as a cultural measure is shown to be a highly effective measure to lower the infestation level of *C. ohridella*, if done precisely and regularly (Gilbert, Svatoš, Lehmann, & Bacher, 2003). Consequent removing of the autumn foliage, in which the pupae of *Cameraria ohridella* are hibernating, leads to a significant reduction in the following spring generation (Greib, Stanke, & Herfarth, 1998). After the collection of the leaves, the foliage must be disposed in waste incineration or compost plants in order to destroy the hibernating pupae by heat (Freise & Heitland, 2003). The temperatures which can be reached in private backyards in small compost heaps are often not sufficient to kill the pupae. Driving

the foliage to proper compost plants or waste incinerations is very time-consuming and postulates that owners have knowledge on locations of such institutions.

An effective and feasible customary horticultural methods is to cover the leaves on the compost with a thick layer (at least 10 cm) of earth or grass (Arnold & Cetin, 2002). Prior shredding of leaves is supportive, as the physical damage to the leaves is leading to a direct death of the pupae. The complete and consequent removal of leaves is of high importance as only few remaining leaves can lead to another strong infestation in spring (Krehan, 1995).

Having discussed other control options above it seems as if foliage removal is the most effective measure concerning price/effort-performance ratio, while taking into account environmental impacts (Snieskiene, Stankeviciene, Zeimavicius, & Balezentiene, 2011).

2.2 Experimental design

This project was conducted by a group of researchers from Technical University of Munich (Prof. W.W. Weisser, Dr. W. Heitland, R. Rogers) and Ludwig-Maximilians-Universität (Prof. H-B Brosius, Dr. C. Wallner, Dr. B. Goodwin, A. Uretschläger) within the framework of the DFG Special Priority Program (SPP 1409) “Science and the General Public: Understanding Fragile and Conflicting Scientific Evidence” (SPP-leadership: Prof. R. Bromme). Theoretical framework for this project was linked to the broader frame of the SPP, in which research projects from psychology, empirical education science, natural science education, communication science, and the sociology of science examined not only how science-related information becomes available but also how laypersons process it. The methodological design of the TUM/LMU-project was developed jointly, and will be explained here more in detail. Besides the manuscripts 1 and 2, which derived through main research questions of the DFG-project, I have put special emphasize on additional theoretical constructs, which I added to the survey of the DFG-Project (manuscripts 3 and 4). Further, I conducted and evaluated an additional student survey (manuscript 5).

For the DFG-project, a survey in 12 German cities as an element of a 2×3 experimental design was conducted. These cities have been selected as “test-regions” based on the infestation level of the horse chestnut leafminer on horse chestnut trees. At the beginning of the project infestation levels of horse chestnut trees in two federal states (Bavaria & Schleswig-Holstein) were identified. Twelve cities were selected, of which half of the cities were determined to show high levels of infestation and the other six cities low infestation. Further, three different journalistic styles of written articles have been designed as treatments for the experiment. Subsequent, questionnaires were developed. The survey was conducted in two waves (first wave from 4/24/2014 to 7/20/2014; second wave from 9/16/2014 to 11/3/2014). In the first wave, one out of three written articles was randomly integrated into the questionnaire. The goal of the second wave was to analyze potential changes, e.g. in risk or nature change perception. In the last phase of the DFG-project we invited participants to visit them at their home in order to discuss and review whether a certain declared environmental behavior was carried out or not.

After having finished the DFG-project, further funding through the Laura Bassi-Award enabled a consecutive research period. The questionnaire from the DFG-project (first wave) was slightly adopted, yet this time participants would solely consist of a sample of students living in a high infested city. The survey was conducted from 4/5/2016 to 7/5/2016. The intention of this study was to compare response behavior and effect sizes of results for the

student sample and the DFG-sample (representative sample). The methodological background is illustrated in manuscript 5.

Within the next chapters, the experimental design will be presented, including selection of cities, the development of the treatments, the construction of the questionnaires, the conduction of the two-wave survey (including the pre-tests), and the implementation of the questionnaire for the student sample.

All statistical analyses have been conducted using the software IBM SPSS.

2.2.1 Identifying test regions

The selection of cities, which serve as regions from where participants for the online questionnaires were recruited, is based on the level of infestation by *Cameraria ohridella* on the horse-chestnut tree.

Identification of infestation levels of horse chestnut trees

For the identification of infestation levels, the most precise methods would be either to count the exact number of mines per leaf or to scan the destruction of a certain number of single leaves, representative for the whole tree. Both methods would be extremely time-consuming and cost-intensive, and are therefore not suitable for this research purpose, as the general intention was to identify regions where damage is strongly visible for the layperson and regions where perception of this nature change is difficult due to low infestation. For this reason, a semi-quantitative rating procedure was chosen. The assessment of infestation levels was done optical, by the same two biologists (Dr. W. Heitland, R. Rogers). Several authors were able to show that the optical assessment of infestation within several infestation categories (Fig. 5) is precise enough to reflect the *Cameraria* population at the chosen site (Gilbert & Gregoire 2003).

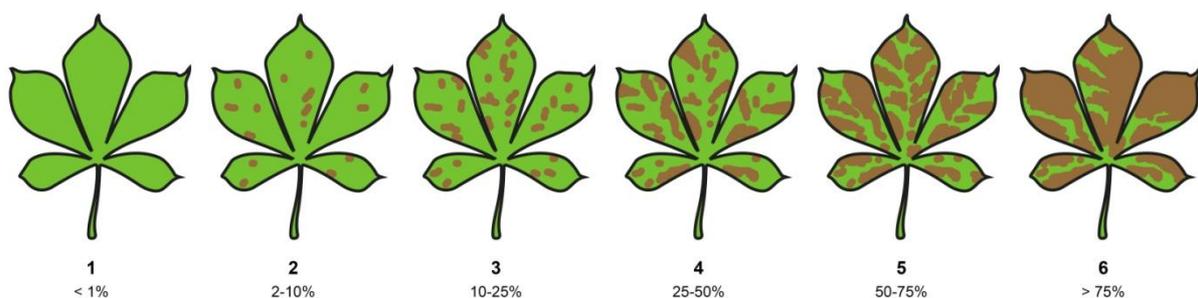


Fig. 5: Pre-defined six categories of infestation levels of *Cameraria ohridella* on horse-chestnut trees.

Choosing Bavaria and Schleswig-Holstein as investigation federal states within Germany, was decided upon two reasons. First, for the chosen states, high experience accounts and data banks from earlier research are existing, which enabled better prediction to ensure high and low infested cities in both federal states. Second, the holiday times of Bavaria (7/30/14-09/15/14) and of Schleswig-Holstein (07/14/14-08/23/14) were both within a suitable timeframe to conduct questionnaires before and after the holidays. The second wave needed to take place after the summer holidays, in order to guarantee the recourse.

Based on previous knowledge about infestation levels of cities, driving throughout Bavaria and Schleswig-Holstein was undertaken in August and September 2013, when possible infestation is strongly visible. When arriving at a city or village, the procedure of finding chestnut trees was always identical. First of all, sites within a city, which are known of often showing horse chestnut appearance, were approached: train stations, churches, cemeteries, park areas (often near governmental buildings), central squares, beer gardens, or restaurants with bigger outdoor areas. When a tree was discovered while driving through the cities, the location, level of infestation and surrounding environmental conditions (pavement, grass, hedges etc.) were documented on prepared spreadsheets. Within Schleswig-Holstein, due to a high amount of infrastructural activity, we were not able to note all exact street names. Within each locality, a minimum number of 15 horse chestnut trees were recorded, to ensure that the infestation level is equally high or low for all trees standing in the corresponding city. A factor of “relevance-affliction” was calculated for each locality to define an overall high infestation level ($> 25\%$) or low infestation level ($< 10\%$). If the overall categorization was not precise, as one or two trees at hotspots showed high infestation while the others low infestation, the locality was not selected as suitable.

Selection of cities for recruitment

Based on the derived list of possible test regions, the small villages were excluded due to later methodological reasons (e.g. limited number of people which can be recruited for questionnaires). Cluster analyses were undertaken to categorize the respective rural districts of pre-selected cities into homogenous clusters concerning key data variables. The intention was to find pairs of cities which show similar levels of respective socio-demographic (e.g. education, age) and environmental conditions (e.g. forest area, recovery area), but vary in their level of infestation. Since available data was not abandoned on every city level, it was not possible to conduct cluster analyses for individual cities. Therefore cluster analyses were based on rural districts and in a second step, cities were afterwards compared manually (high

vs. low infestation). Thus first “cities” and bigger villages (“markets”) were assigned to their respective rural district. For Schleswig-Holstein those rural districts were: Dithmarschen, Nordfriesland, Rendsburg-Eckernförde, Segeberg, Steinburg and two rural district free cities (Flensburg & Kiel). For Bavaria the following districts were apparent: Nürnberger Land, Donau Ries, Neuburg-Schrobenhausen, Aichach-Friedberg, Fürstenfeldbruck, Landsberg a. Lech, Unterallgäu, Oberallgäu, Ostallgäu, Weilheim-Schongau, Bad Tölz, Wolfratshausen, Miesbach, Erding, Rosenheim, Traunstein, Berchtesgardener Land, Mühldorf am Inn, Altötting, Rottal-Inn and the rural district free city Kaufbeuren. Key data on the demographic situation was obtained by the “Zensus Datenbank 2011” and the “Regionaldatenbank”, as these datasets were accessible. The compared key variables were:

- i) Number of people with university entrance diploma;
- ii) Number of people oscillating for working reasons to another area;
- iii) Fraction of recovery and forest area;
- iv) Age-distribution within a five scale ranking;
- v) Number of inhabitants;
- vi) Population density;
- vii) Number of free-standing houses;

Cluster analysis was first done for Bavaria and Schleswig-Holstein separately. Data was standardized on z-values and clusters were identified (Ward-method). Through clusters obtained, the relevant cities were listed manually with the number of inhabitants and level of infestation next to their rural district. Pairing criteria was done to select one city with high and one city with low infestation. Three pairs of cities for each federal state were chosen (Fig. 6). Even though infestation levels can be predicted depending on the infestation level of previous years, other external factors, such as weather conditions, can influence the level of infestation (Gilbert et al., 2005). Thus in summer 2014 driving through the same cities was done in order to re-check whether infestation levels varied or stayed constant. In Bavaria the city “Rain”, which was supposed to be “low infested”, showed an unexpected high infestation level. Also other cities in the surrounding, which were identified as low infested cities in autumn 2013, showed extremely high infestation levels. In Schleswig-Holstein, the city “Niebüll” showed low infestation in spring 2014, different to what was identified in autumn 2013. Nevertheless, the final decision was to keep those 12 cities, yet define them in the appropriate category of “low” or “low” respective to the year 2014 (Fig. 6):

Schleswig-Holstein:

Pair 1:

Kellinghusen (7,828 inhabitants, district of Steinburg, high infestation)

Meldorf (7,261 inhabitants, district of Dithmarschen, low infestation)

Pair 2:

Niebüll (9,582 inhabitants, district of Nordfriesland, high infestation 2013/low infestation 2014)

Brunsbüttel (12,834 inhabitants, district of Dithmarschen, low infestation)

Pair 3:

Rendsburg (27,592 inhabitants, district of Rendsburg-Eckernförde, high infestation)

Kaltenkirchen (19,709 inhabitants, district of Segeberg, low infestation)

Bavaria:

Pair 4:

Simbach am Inn (9,579 inhabitants, district of Rottall-Inn, high infestation)

Rain (8,344 inhabitants, district of Donau-Ries, low infestation 2013/high infestation 2014)

Pair 5:

Traunstein (18,635 inhabitants, district of Traunstein, high infestation)

Füssen (14,277 inhabitants, district of Oberallgäu, low infestation)

Pair 6:

Fürstenfeldbruck (33,379 inhabitants, district of Fürstenfeldbruck, high infestation)

Wasserburg (19,941 inhabitants, district of Rosenheim, low infestation)

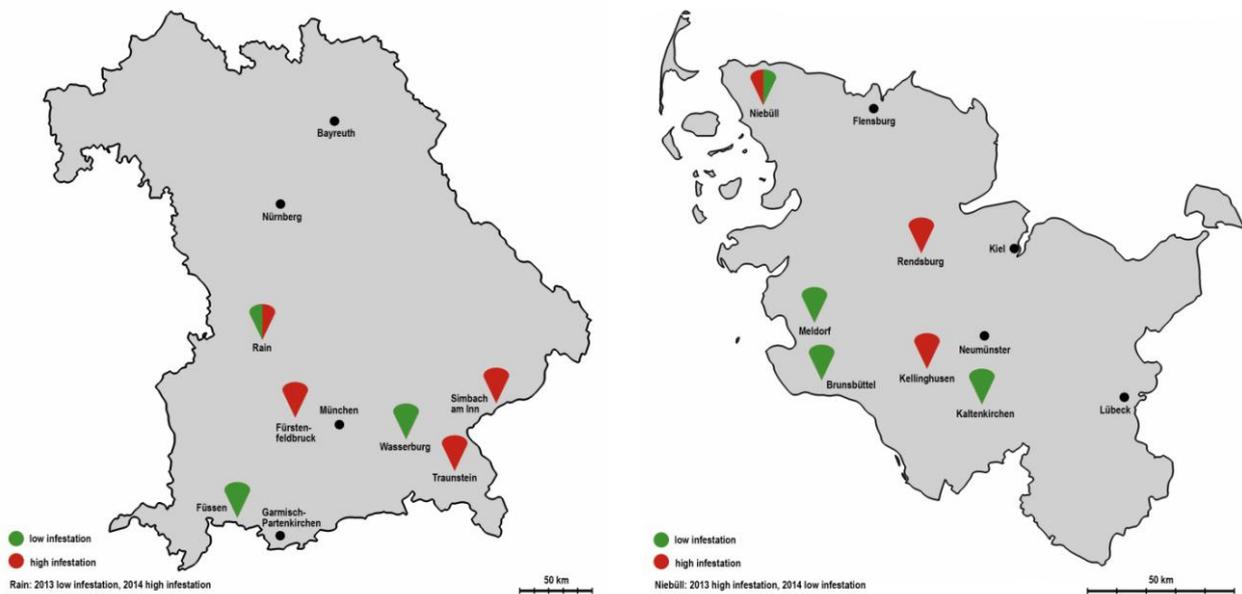


Fig. 6: Map of Bavaria and Schleswig-Holstein with test-cities and level of infestation

2.2.2 Treatments

Three different styles of written articles, which could be published in a newspaper or online version, were written in cooperation with professional journalists. The defined styles were:

- 1) tabloid (Fig. 7a)
- 2) quality-press (Fig. 7b)
- 3) popular/scientific magazine (Fig. 7c)

For the student survey a control article (Fig. 7d) was included, which would be categorized as quality-press article, yet it was based on a very different topic. This was done to double-check the effect of showing a treatment in between the questionnaire.

Detailed information and literature on varying and common characteristics of the different treatments are found in chapter 4, 5 and 7 (manuscript II, III, and V) and thus will not be repeated in this section.

a) tabloid

Angriff der Balkan-Motte!

Der Kastanienschädling ist zurück. Forscher warnt: »Die Motten sind überall«.

Unsere schönen Kastanien! Noch sprießen die zartgrünen Blätter. Doch wir müssen uns Sorgen machen: Motten-Alarm! Der Kastanie, dem Symbol heimischer Gemütlichkeit, droht Blattsterben. Die Kastanienmotte aus Osteuropa hat sich in unseren Kastanien eingenistet. Dieses Jahr droht eine Motten-Invasion. Wenn die Motten-Invasion nicht aufgehalten wird, müssen wir uns auf traurige Aussichten einstellen: ein Dach aus braunen Laubresten statt sommerlich-frischem Grün.

Der braun-weiße Schädling legt Eier auf die frischen, schutzlosen Blätter. Die gierigen Raupen fressen sich durch die grünen Kastanien-Blätter. Die verwelken noch vor dem Sommer. Und fallen ab. Braunes Laub statt grünem Blätterdach.

Das Ende der Kastanien

Die Kastanie kann ohne Blätter nicht »atmen«. Der Baum wird dauerhaft geschwächt. Im schlimmsten Fall müssen die Bäume gefällt werden. Experten glau-

ben: Das ist das Ende der Kastanie.

Die Kastanienmotte tauchte vor wenigen Jahren auf. Zuerst in den deutschen Großstädten. „Wahrscheinlich wurde sie von Menschen eingeschleppt“, sagt Mottenexperte Werner Heitland.

Motten sind Aliens

Die Motten sind Aliens, haben hier keine natürlichen Feinde. Eingeschleppt aus Mazedonien, kamen sie in unsere Städte. Ob in Düsseldorf, München, Hamburg oder Berlin: Die prächtigen weißblühenden Kastanien sind seit Jahren befallen. Mottenforscher Heitland war unterwegs, hat Proben gesammelt: „Die Motten sind überall. Ich habe keine weißblühende Kastanie mehr ohne Motten gesehen“, so Heitland. Er ist sich sicher: Wir werden die Motten nie mehr los!

Vor allem Bayern gilt als Motten-Gefahrengebiet. Hier sind die Motten nun auch in ländlichen Regionen angekommen.

Im Kampf gegen die Alien-Motte sind Forscher immer noch ratlos. Die bekannten Gifte sind

teuer, umweltschädlich oder teilweise verboten. Was unseren Kastanien hilft? „Nur Laubkehren brachte bisher etwas Erfolg“, sagt Mottenexperte Heitland. »Wundermittel sind nicht in Sicht«.

80.000 Motten aus einem Sack Laub

Die Blätter sind Sonderabfall, können in Gartenabfallsäcken bei der Stadtreinigung zur ordnungsgemäßen Entsorgung abgegeben werden. Denn die Mottenlarven überleben bis zu -20 Grad. Jedes Blatt ist eine Gefahr. Heitland: „Aus einem Sack Laub kommen 4.000 Motten. Das sind 80.000 neue Eier.“

So erkennen Sie die Motten: kreisrunde, braune Flecken auf den Blättern heißt Mottenbefall. Schockierend: dann ist es bereits zu spät! Retten Sie unsere Kastanien: Die Puppen überwintern im Laub. Sammeln Sie sorgfältig jedes Blatt ein – mehrmals im Jahr. Die Motten vermehren sich ständig. Gartenabfallsäcke gibt es beim Gartenamt. (Red)

b) quality-press

Die Kastanienmotten sind nicht aufzuhalten

Eingeschleppter Schädling bedroht Kastanien jetzt auch in ländlichen Regionen

Ein Kastanienblatt - kreisförmige, braune Flecken auf den Blättern sind das deutliche Zeichen für die Anwesenheit der Larve der Kastanienmotte. Das Todesurteil für das Blatt. Nach Einschätzung von Experten werden im Sommer wieder viele Kastanien braun verfärbt wie im Herbst sein. Die gefräßigen Larven der Kastanienmotten sorgen seit mehreren Jahren dafür, dass deutsche Kastanien bereits im Sommer anfangen ihre Blätter abzuwerfen. Es ist kein schöner Anblick. Mit welcher Motteninvasion wir dieses Jahr zu rechnen haben, ist laut Experten vollkommen unklar.

Die deutschen Großstädte kennen das Problem seit Jahren. Die Kastanienmotte wurde vor dreißig Jahren erstmals in Mazedonien entdeckt. Mit dem Fernverkehr hat sie sich über Straßen und Schienen ausgebreitet. Das verschaffte ihr den Beinamen »Trampermotte«. „Wahrscheinlich wurde sie von Menschen eingeschleppt“, sagt Forstbiologe Werner Heitland von der Technischen Universität München, der die Motten erforscht.

Jetzt droht die Plage auf die ländlichen Regionen überzugreifen. Die Landratsämter in Bayern sind alarmiert. Heitland ist wieder 6000 Kilometer durch Deutschland gefahren. Er sagt: „Ich habe nicht einen einzigen Baum gesehen, der nicht befallen war.“

Die Motten legen ihre Eier auf den Kastanienblättern ab. Die Larven bohren sich genüsslich einen Gang in das frische Blatt, das abstirbt. In nur zwei Wochen schlüpft aus der Larve ein neuer Falter. Aus einem Kilo Laub schlüpfen bis zu 4.000 Motten.

„Die Aussicht, die Motten wieder ganz loszuwerden, ist gering“, sagt Heitland.

Jetzt hilft Laub sammeln

Noch immer wissen die Wissenschaftler nicht, woher die Motte ursprünglich kommt. Das ist deshalb so wichtig, weil es dort natürliche Feinde der Motte geben könnte. Ein sicheres Gegenmittel gibt es nicht. „Ein Wundermittel ist nicht in Sicht“, sagt Heitland. Es laufen Forschungen an chemi-

schen Mitteln und Versuche mit natürlichen Fressfeinden der Motte. Auch die Tatsache, dass ausschließlich weißblühende Kastanien betroffen sind, die kleineren rotblühenden Kastanien den Motten widerstehen, könnte ein Ansatz für ein Gegenmittel sein. „Nach meiner Erfahrung hilft am besten Laubsammeln, weil die Puppen im Laub überwintern“, sagt Heitland. Immerhin: Die Kastanien scheinen den Befall besser wegzustecken als zu Beginn befürchtet. „Das ist mehr ein ästhetisches Problem“, sagt Kastanienexperte Heitland. „Langfristig wird man die Kastanie durch andere Bäume ersetzen.“

Also heißt es wieder Laubsammeln. Dabei kommt es auf jedes Blatt an. Das Laub sollte gründlich eingesammelt werden. In Gartenabfallsäcken kann es bei der Stadtreinigung abgegeben werden, wo es ordnungsgemäß entsorgt wird. So haben die Motten einen schweren Stand. Noch ist unklar, ob die städtischen Gartenämter selbst Laubsammelaktionen starten – denn diese sind aufwändig. (Red)

c) popular/scientific magazine

Kastanienmotte hat sich etabliert

Herkunft des Kleinschmetterlings gibt weiter Rätsel auf

Ein Kastanienblatt mit kreisförmigen, braunen Flecken – die Fraßspuren eines Pflanzenparasiten. Es ist die Larve der Roßkastanien-Miniermotte (*Cameraria ohridella*), einem Kleinschmetterling. Ihr Hauptwirt ist die gemeine, weißblütige Rosskastanie (*Aesculus hippocastanum*). Sie frisst einen Gang durch das Blatt, das abstirbt. Das Bild der schon im Sommer braun verfärbten Kastanien ist in deutschen Großstädten verbreitet.

Dieser Minierer verursacht seit mehreren Jahren dafür, dass Gemeine Kastanien bereits im Sommer anfangen ihre Blätter abzuwerfen. Die kleinere rotblütige Kastanie (*Aesculus carnea*) scheint dagegen immun gegen die Parasiten zu sein. Erstmals wurde die Motte 1985 in Mazedonien am Ohridsee beobachtet. Ob sie daher kommt oder dort auch nur eingewandert war, ist aber unklar. Unter anderem mit dem Fernverkehr, hat diese invasive Art sich über Straßen und Schienen ausgebreitet. Erstmals 1994 wurde sie in Deutschland beobachtet. „Wahrscheinlich wurde sie von Menschen eingeschleppt“, sagt Forstbiologe Werner Heitland von der Techni-

schen Universität München, der die Motten seit Jahren erforscht.

Die Herkunft der Motte ist interessant für die Suche nach natürlichen Fressfeinden, sogenannte Parasitoide. Denn noch gibt es keine. Auf *Cameraria* spezialisierte Parasitoide wären ein wirksamer Ansatz zur Bekämpfung. Denn alle anderen vielversprechenden Ansätze erwiesen sich bisher als wirkungslos. Selbst Prädatoren wie die Meise, können die Population nicht regulieren. Insektizide lassen sich in Städten kaum großflächig einsetzen und verursachen ökologische Probleme. Auch Nahrungsknappheit oder strenge Winter machen der Motte nichts aus. Studien bestätigen: Die Motte hat sich hierzulande fest etabliert.

Laubsammeln als wirksame Maßnahme

Immerhin: Die Kastanien scheinen den Befall besser wegzustecken als zu Beginn befürchtet. Die Nettophotosyntheserate ist nur 20% niedriger. „Das ist mehr ein ästhetisches Problem“, sagt Heitland, „in 20 Jahren ist kein Baum wegen

der Motte abgestorben“. Die Globalisierung und der zunehmende Warenverkehr führen dazu, dass sich invasive Arten wie die Kastanienminiermotte immer schneller ausbreiten. Ironie der Geschichte: Auch die Gemeine Rosskastanie ist keine heimische Art: Sie stammt aus dem Balkan.

Das erfolgreichste Gegenmittel scheint Laubsammeln. Das Laub muss großflächig vor allem komplett eingesammelt werden. Während die Puppen den privaten Kompost überstehen, tötet die großtechnische Kompostierung oder ordnungsgemäßes Verbrennen der Stadtreinigung die Nachkommenschaft. Großangelegte organisierte Laubsammelaktionen, wie sie in Berlin stattfanden, sind aufwendig und kostenintensiv. „In einem unserer Versuche schlüpfen aus einem Kilo Restlaub 4.000 Motten. Das entspricht 80.000 neuen Eiern in der folgenden Generation“, sagt Heitland. Auch steht das Laubsammeln im Konflikt zur Praxis, das Laub aus ökologischen Gründen bewusst für andere überwinternde Insekten und Kleinlebewesen wie Igel liegen zu lassen. (Red)

c) control article

Farbverdünner im Pferde-Erbgut

Weiß oder grau? Wie entsteht die Farbe des Fells bei Pferden?

Weihnachtszeit ist Märchenzeit - und mit ihr galoppieren immer wieder Schimmel oder Rappen als mobiler Prinzenuntersatz durch die Vorlesebücher. Dazwischen existiert farblich wenig, und das kann tatsächlich nur ein Märchen sein. Denn sowohl schwarze, als auch weiße Pferde waren über viele Jahrtausende hinweg eher genetische Unfälle.

Ursprüngliche Pferderassen sind bis heute in Sand- oder Erdfarben getönt, mit dunkleren Mähnen, Schweifen und teils markanten Strichen am Körper. Pferdeexperten sagen „falbfarben“ dazu. Auf freien Flächen sind Falben wie das Przewalski- oder das Dülmener Wildpferd mit diesem unregelmäßigen Farbmuster gut getarnt. Wie aber entsteht es genau? Und warum ist es beim Hauspferd fast verschwunden?

Genetiker befassen sich schon seit vielen Jahren mit der hochkomplexen Vererbung von Pferdefellfarben. Die Existenz eines bei Falben vorhandenen Dun-Gens (dun ist das englische Wort

für falb) wird dabei als sicher angenommen.

Das Dun-Gen verteilt Farbpigmente im einzelnen Haar des Pferdes

Es bewirkt, dass die Grundfellfarbe, zumeist braun, ins Blasse hinein verdünnt wird. Es gibt weitere solche Farbverdünner im Pferde-Erbgut, wie zum Beispiel das Creme-Gen, die zu einer vollständig verblassten Färbung führen. Unklar blieb jedoch die Identität des Dun-Gens - und warum der Effekt hier nicht den ganzen Körper betrifft.

Erbgutanalysen von Wildpferden

Im falbfarbenen Pferdehaar führt der Faktor dazu, dass in der Seite, die dem Körper des Pferdes zugewandt ist, kein Farbstoff ins Haar eingelagert wird - auf der nach außen zeigenden Seite jedoch schon. Diese halbseitige Tönung innerhalb einzelner Haare bewirkt den Verdünnungseffekt

der Farbe von braun zu fahlgelb bis hellgraubraun. Außerdem wird das Dun-Gen nicht an allen Stellen des Körpers gleichmäßig abgelesen. Entsprechend zeigen die Falben unregelmäßige Muster mit einzelnen Streifen. Womöglich ist das Dun-Gen sogar für die einzigartige Zeichnung von Zebras verantwortlich, spekulieren die Forscher.

Die Wissenschaftler machten darüber hinaus noch eine zweite Entdeckung: Es gibt vom Falb-Gen nämlich nicht nur jene zwei Varianten, die zwischen Falb- und dunkler Farbe unterscheiden. Eine weitere Form kann eine Fellfärbung und -musterung erzeugen, die aufgrund ihrer Rückenstreifen bisweilen als Falb missinterpretiert wird. Vermutlich entstand erst aus dieser Variante die neue, vollständig einheitliche und dunkle Färbung des Fells beim Hauspferd, schreiben die Wissenschaftler in ihrem Aufsatz. Das belegten Erbgutanalysen von Wildpferden, die vor 45 000 Jahren lebten. (Red)

Fig. 7a-d: The a) tabloid, b) quality-press, c) popular/scientific magazine for participants from Bavaria and the d) control article for the student survey¹

¹ changed from Süddeutsche Zeitung article by Kathrin Zinkart (25.12.2015) with permission

2.2.3 Questionnaires

On the basis of our above-mentioned aims (chapter 1) and the hypotheses of the later presented chapters, valid scales for our variables were searched by means of literature review. When identified, scales were adopted to our research topic. The complete questionnaires (wave one & two) of the DFG-project can be found in the appendix A. In each of the following chapters there will be a complete illustration of the elaboration of the relevant constructs, items, means and correlation indices.

The questionnaires of the DFG-project aimed at deriving a sample representative for the general public of Germany. The first wave of the DFG-project questionnaire was the basis for the second wave and the student questionnaire. For the second wave, the questionnaire was reduced to the relevant aspects for longitudinal investigation. Further, some questions on ecological knowledge were added (see appendix A & chapter 6/manuscript 4). The student questionnaire was almost identically with the first wave of the DFG-project. A few irrelevant questions were deleted (see appendix A: Q3, Q29, Q30, Q32), a control treatment added (Fig. 7d), and two questions were rephrased (see appendix A: Q31 - media usage in minutes instead of categories; Q37 - postal code instead of city). Further, students were not asked whether they would like to have some biologist visit them, as we argued that not many students would own a garden with chestnut trees.

Pre-test

Each questionnaire must be tested empirically by a “pre-test” before starting the process of data acquisition. Pre-tests check measuring instruments and determine whether valid and reliable measures are provided. Extensive pre-tests are of high importance in the process of developing high quality and authentic questionnaires. Pre-tests offer the possibility to eradicate and control problems or misunderstandings before the official data acquisition begins (Schnell, Hill, & Esser, 2008). Different aspects need to be checked:

- i) Sufficient variation in responses;
- ii) Understanding the questions (respondent);
- iii) Interest and concentration of the respondent concerning the questions;
- iv) Continuity of the interview cycle (“flow”);
- v) The effect of the order of questions;
- vi) Quality of filter guidance;
- vii) Context effects;

- viii) Duration of the survey;
- ix) Interest of the respondent concerning the whole survey/interview;
- x) Strain (emotional pressure) of respondent through survey/interview;

Starting Friday, the 4/18/14 to Wednesday, the 4/23/14, 30 pre-tests for the questionnaire of the first wave (DFG-project) took place in Munich. Each of the treatments was integrated ten times into a questionnaire. The pre-tests were carried out “face-to-face” and “paper & pencil”. Face-to-face interviews normally have a very high response rate (Hox & De Leeuw, 1994). Further they are known as very useful, because they reduce “missing data” as questions of the participants can be answered on the spot by the interviewer. The possibility for respondents to ask the researcher questions during the survey and the option for the interviewer to observe the respondent and note down any peculiarity will describe a clear picture of how adequate the questionnaire is (Converse & Presser, 1986). The length of the responses, the pausing at questions and the questions that were directed to the researchers were documented. Following a pre-test protocol, each participant was directly questioned about the clarity and the understandability of the questions. The average duration of answering the questions was 18 minutes with a minimum of 10 minutes and a maximum of 30 minutes. The pre-test illustrated many aspects and arose hints, which questions or certain words needed to be reformulated. Filters were changed and “don’t know” categories were added. Because the questionnaire was reported as too long by 28 of 30 respondents, single items were deleted. Additionally, a treatment check took place.

Besides changes, which were addressed due to information given by participants, the questionnaire was completely checked with an adapted FBS system (Faulbaum, Prüfer, & Rexroth, 2009). The rating system FBS is an instrument with which researchers can check threats to the quality of questions. This instrument enables a critical reflection of form and content of the questionnaire. With the help of the FBS checklist, each question can systematically be optimized. Even though this instrument is primarily constructed in order to identify threats and problems, it offers also assistance with clearance of these problems. The usage of an FBS still can not substitute a pre-test, but may help additionally.

For the second wave mostly scales from the first wave were used. The pre-test for the second wave (15 participants - 8/10/2014 to 8/20/2014) revealed only a few additional hints. The length of the questionnaire was adequate, with people showing an average response time of 4 minutes.

For the student survey, the questionnaire was relatively similar to the first wave of the DFG-project (see changes above at subchapter 2.2.3). A pre-test with 20 students (3/15/2016-3/22/2016) gave no further hints. Students completed the pre-test in 16 minutes on average.

Online version

Online-questionnaires (two waves of the DFG-project and student survey) were programmed using the tool “SoSci Survey” (Leiner, 2012). Face-to-face interviews are not feasible taking into account the distribution of the participants. Technical elements, such as filters or randomization of treatments, were programmed via PHP-code. Research assistants of the project conducted the technical control of the online questionnaires. In addition, the Social Scientific Survey Centre (SUZ), who was responsible for recruiting participants for the DFG-project, double-checked the smooth running of the questionnaires, also taking into account different internet browsers. Because the treatments contained different local references for inhabitants living in Schleswig-Holstein and Bavaria and data from the first and second wave should be linked in an anonymized form, individualized links were provided for each respondent in Bavaria and Schleswig-Holstein. Every link could only be used once and was sent by the SUZ straight to the e-mail account of the elective respondent.

Recruitment

For the recruitment of participants for the DFG-project, the Social Scientific Survey Centre (SUZ) contacted participants in the 12 selected cities in Bavaria and Schleswig-Holstein using CATI-recruitment (Computer Assisted Telephone Interviews). Recruiters first asked whether they could speak with the person whose birthday is up next. Second it was secured that this person is between 18 and 60 years old. The person then was asked to answer three introductory short questions, to build up a conversation and interest:

- i) The first question refers to deciduous trees in your city or community. Have you noticed that some trees are infested by pest species? (yes/no)
- ii) How is the situation of horse chestnut trees in your city/community: Have you noticed that the leaves of those trees turn brown already early in summer? (yes/no)
- iii) Have you, independently how strong the infestation of trees with pest species is in your surrounding, engaged yourself with the topic of pest species? (yes strongly/rather yes/partly/rather no/no strongly)

Subsequently, the SUZ explained the respondents that a longer questionnaire (with image material) is available online and asked whether they would be interested to take part. If

approved, the e-mail address of the respondent was recorded and one of the individualized links was sent to the person directly. The participants also had to agree to take part in a second wave in autumn 2014.

The required sample size was calculated via power-analysis for the DFG-project. $N=105$ respondents per test group were prescribed as optimal sample size, if medium effects (Cohen's $d = 0.5$) and type I & II error of 0.05 are assumed. This would lead to a sample size of 630 participants in total. As response rates were expected to be only 80% in the second wave, 788 participants needed to be recruited by the SUZ.

The SUZ had called 19.166 numbers in our 12 selected regions. At the end 879 e-mail addresses were collected, yet 79 e-mail addresses were incorrect, leaving 800 for our online questionnaire (400 in Bavaria & 400 in Schleswig-Holstein). Only 530 participants took part in the first wave of the online questionnaire (DFG-project). Since not all of these people finished the survey, a sample of 479 will be used in the first wave dataset. 74 people had expressed an interest of a visit by an expert from the Technical University of Munich, but when those people were contacted and dates were offered, only eleven people (six in Bavaria and five in Schleswig-Holstein) arranged an appointment. Results from visits will be discussed in chapter 8. For the second wave of the DFG-project only 295 people took part.

Even though the sample size is smaller as has been previously defined as "optimal", power-analysis reveals that still medium to big effects become apparent also for the smallest group comparison in the 2x3 experimental design. Main effects can also be illustrated with small effects, while for interactions only big effects will be visible.

The student sample recruitment was done using the method of "snowball sampling". Even though this approach is often criticized for delivering not-representative samples, it is frequently used in social sciences (Bryman, 2008). The web link of the online questionnaire was distributed using official mailing lists from the three universities of Munich (TUM, LMU, and University of Applied Sciences Munich) and through mailings lists and Facebook pages of departments' student representatives. Target audience was students living in the high infested city of Munich and close surrounding. A total sample of $N = 277$ completed the questionnaire. This size was the targeted goal to compare the group of students with participants of the DFG-project living in high infested areas.

Chapter 3-8: Manuscript overview

This thesis contains five manuscripts, for which a brief summary, the publication status and the contribution of the authors is given:

Chapter 3: Manuscript I

When do People take Action? The Importance of People's Observation that Nature is changing for Pro- Environmental Behavior within the Field of Impersonal, Environmental Risk.

Rogers R, Wallner C, Goodwin B, Heitland W, Weisser WW, Brosius H-B

Published 2017 in Journal of Integrative Environmental Sciences, 14:1, 1-18.

The first manuscript evaluates how people's perception of a current change to the natural environment may alter their risk perception and pro-environmental behavior. Previous research has shown that prior experience is a highly influencing factor for risk perceptions and behavioral patterns. Yet, often prior experience is connected to a personal threat and damage, e.g. cancer or damage through flooding. We assumed that people's mere perception of nature changes, even if it is an impersonal risk and therefore not threatening humans but rather nature, is crucial for explaining effects in environmental and risk communication. Thus in this publication we discuss 1) how people perceive nature change differently, 2) the relation to individual risk perception, and 3) effects on behavioral intentions regarding our impersonal nature change. A joint survey of biologists and communication scientists was conducted within a field experiment in two waves ($N_1=479$; $N_2=295$) in 12 German districts. Those regions differ in observable nature changes, evoked by the invasive moth *Cameraria ohridella*, which creates early leaf foliage on white flowering horse chestnut trees. Results show that the biological method, of deciding on sampling regions, helps to define a sample of participants, who show different extents in nature change and risk perception. People living in high infested areas, showed higher nature change perception and risk perception. Mediation analysis reveals that the overall effect of nature change perception on communicative and another active pro-environmental behavior ("to take part in collective leaf disposal") is almost completely mediated by risk perception. The results indicate that the objective proximity and visibility of a nature change seems to be influencing the individual observation that nature is changing and thus the consequent risk perception, even if the nature change is defined as impersonal risk. Further the results indicate that the mere perception is an important factor

Chapter 3: Manuscript I

explaining behavioral adoption through increasing risk perception. For impersonal risks, it was shown that the mere perception of a nature change may be a possible tool to influence risk perception and throughout behavioral patterns related to nature changes.

RR and CW conceived the idea for this manuscript. RR, CW, WH, BG, HBB and WWW prepared the survey. RR analyzed the data and wrote the first manuscript draft, which was edited by CW, HBB and WWW.

Chapter 4: Manuscript II

Effects of Nature Change Perception and Media Reporting on Impersonal Risk Perception.

Wallner C*, Rogers R*, Goodwin B, Heitland W, Weisser WW, Uretschläger A, Brosius H-B

*Both authors contributed equally

In Preparation.

This manuscript investigates how media reporting on an impersonal environmental change influences people's risk perception. The effective communication of environmental risks is central for good environmental change management. Nevertheless more research is necessary for understanding effective written article usage as environmental communication tool. The goal was to study 1) the effect of different styles of written articles about an environmental risk onto people's risk perception on personal and societal level, and 2) the combined influence of written articles and people's perception that nature is changing for risk perception. The horse chestnut leafminer (*Cameraria ohridella*) was chosen as case example, as it evokes an impersonal nature change, which is perceivable for laymen. In an experimental design three written articles about the case example were varied in different qualitative elements through using different styles (tabloid, quality-press, popular/scientific magazine). It was shown that participants (N = 400) distinguish between different qualities of articles. Furthermore, risk perception was rated higher after the treatment, indicating an effect of media on personal and societal risk perception. The popular/scientific article (e.g. highest quality & complexity) showed the lowest influence on change of risk perception, while the quality-press (e.g. medium quality & complexity) indicated the highest. We could show that prior experience through perceiving an environmental change varies prior risk perception, and thus determines the additional effect of media. The media effect was lower for people with high nature change perception and consequently higher prior risk perception, while the influence was bigger when people have not observed the nature change before. Overall, results emphasize the influence of mass media on the communication of impersonal

Chapter 4: Manuscript II

environmental risks. Therefore we advise journalists and scientists to report in the proposed style.

CW and RR conceived the idea for this manuscript. CW, RR, AU, WH, BG, HBB and WWW prepared the survey. RR analyzed the data and wrote the first manuscript draft. CW edited the whole manuscript.

Chapter 5: Manuscript III

Analyzing the Existence and Relation of Optimistic Bias and First-Person Perception for an Impersonal Environmental Change.

Rogers R, Wallner C, Goodwin B, Heitland W, Weisser WW, Brosius H-B

Published 2017 in International Journal of Communication 11:1466–1485.

This manuscript investigates two theoretical concepts of perceptual distortions. The aim of this publication was to analyze whether a visible nature change, which is not threatening humans directly, may evoke distortions in perceptions as has been shown for many personal risks. We examine 1) the optimistic bias for an impersonal risk, i.e. the tendency that people think that others are at a greater risk of being affected than they themselves, and 2) the first-person perception for an impersonal risk, i.e. the tendency of people to think that they themselves get influenced more heavily by media coverage than other people. We identify 3) the influence of written media articles and proximity of the impersonal risk on first-person perception (FPP) and optimistic bias (OB). Finally we investigate 4) the relationship between OB and FPP. We conducted a field experiment (N = 479) in 12 German cities where an invasive moth species (*Cameraria ohridella*) had infested culturally important horse chestnut trees. We found OB for this nature change that decreased for people living in an area subject to this impersonal nature risk. After the treatments neither the impersonal risk's proximity nor the journalistic style of media reporting had a significant effect on the OB. An FPP was found which was neither influenced significantly by different journalistic styles nor the impersonal risk's proximity. A non-significant swap-in-signs relation between OB and FPP was found depending on journalistic style. Our research key findings further develop our knowledge about OB and FPP as we could show that also for impersonal risks these distortions are present and may have potential influences on people's consequent pro-environmental behavior.

Chapter 5: Manuscript III

RR, CW and HBB conceived the idea for this manuscript. RR, CW, WH, BG, HBB and WWW prepared the survey. RR analyzed the data. RR wrote the first manuscript draft, which was edited by HBB, CW and WWW.

Chapter 6: Manuscript IV

Factors Influencing Ecological Knowledge and its Effect on Information Processing and Communicative Behavior.

Rogers R, Wallner C, Goodwin B, Heitland W, Weisser WW, Brosius H-B

In Preparation.

Despite the fact that many studies show that environmental knowledge relates poorly in a direct way to environmental behavior, many organizations and institutions still built their campaigns on knowledge transfer. In this manuscript we evaluated factors that may influence people's basic ecological knowledge and how knowledge relates to people's environmental behavior with respect to our impersonal nature change. Thus we examined 1) how socio-demographic factors and garden ownership influence ecological knowledge, and 2) how ecological knowledge relates to environmental worry, information processing, and communicative behavioral intentions. A two-wave field experiment (N = 295) in 12 German cities, where an invasive moth (*Cameraria ohridella*) had infested important horse chestnut trees, showed that for this impersonal risk, education, age, and garden ownership influenced basic ecological knowledge. In general we observed the trend that the older and the more educated the participants, the higher their ecological knowledge. Further we found that participants owning a garden showed a higher ecological knowledge. Yet knowledge and environmental worry did not directly influence behavioral intentions, but indirectly through "need for cognition", which then directly impacted behavior. Furthermore, the relation between environmental worry and ecological knowledge was significantly negative; those more worried seemed to know less about ecology. Our results thus are in accordance with many other studies on personal risks, indicating that also for an impersonal risk, knowledge is not directly influencing people's behavioral intentions.

Chapter 6: Manuscript IV

RR, CW and HBB conceived the idea for this manuscript. RR, CW, WH, BG, HBB and WWW prepared the survey. RR analyzed the data. RR wrote the first manuscript draft, which was edited by HBB, CW and WWW.

Chapter 7: Manuscript V

Comparing the Validity of a Representative versus Student Sample in Environmental, Impersonal Risk Research.

Rogers R, Weisser WW, Wallner C, Brosius H-B

In Preparation.

The background of this manuscript is that a high amount of research is relying on college or student samples, as the costs and efforts are lower than for representative sampling. Yet this approach receives a lot of criticism, as it is postulated that students are “unfinished personalities” - only representing a specific level of age and education and may not be representative of “people in general”. In 2014, we conducted an online questionnaire with a representative sampling using CATI-recruitment. In 2016, the same questionnaire dealing with an environmental, impersonal risk, was undertaken with a student sample. Correlation indices, standard deviations and effect sizes for risk perception, optimistic bias, first-person perception and the influence of distinct journalistic styles, varying in different qualitative elements, on risk perception were compared for both samples. Our results indicate that students' samples can reveal relatively similar results compared to the results of a representative sample for some contents, in our case the optimistic bias or the effect of journalistic styles on risk perception, but it may also result in a total different outcome: we found a first-person perception (FPP) for the representative dataset, yet no distortion in perceived media influence for the student sample. We conclude that the empirical evidence that does exist is very inconsistent and it seems difficult to forecast a meaningful generalization when using student samples. We suggest that if an overall representative sample is not possible, using small representative control groups to identify potential strong differences should be added to the commonly used student samples.

RR, CW and HBB conceived the idea for this manuscript. RR prepared the survey. RR analyzed the data and wrote the first manuscript draft, which was edited by WWW.

Chapter 8: General Discussion

As introduced in chapter 1, geologic records show that Earth's systems and life forms have always undergone change (Warner et al., 2012). Environmental changes (either anthropogenic or natural driven), like species loss, are major global risks for nature, which will affect humanity in the long run (Callens et al., 2011; Habel et al., 2011). Other changes to the natural world such as water scarcity are already becoming major threats to human survival (Heinrichs & Grunenberg, 2009). This current condition of humans is described by Ulrich Beck, as "risk society" (*Weltrisikogesellschaft*) (Beck, 2007) and thus research on risk and human perception about risks has received raising interest. Most studies have evaluated people's environmental risk perception as their perception of personal risks, whereby a natural hazard like flooding or an earthquake may be perceived and experienced as an actual personal threat. This thesis was concerned with another category of people's risk perception: changes to the natural world that do not directly cause harm to people, but that threaten their immediate environment. Lee Ann Kahlor and others introduced the term "impersonal risk" in contrast to "personal risk" (Kahlor et al., 2006). As described in chapter 1, the tangible effects of many such risks, like the loss of biodiversity, are generally negligible at first. Yet many emerging social, economic, environmental, or physical consequences could be reduced through the early adoption of risk-reducing behavior or voluntary actions. For example, in the case of the loss of biodiversity, early conservation of species would prevent loss or changes to species composition, thus averting or reducing negative effects on the services humans need from ecosystems. Early behavioral patterns may therefore serve to increase or decrease later physical risks (Kasperson et al., 1988). Thus, research on impersonal risk is a hot topic. In order to enhance the effectiveness of environmental communication, a thorough understanding of the concept of impersonal risks is crucial. While knowledge on many personal risks is already profound, there is a lack of studies on impersonal risks, even though many researchers and practitioners see the need to understand how those environmental changes may be communicated most effectively and how human perceptions and attitudes are formed and fostered. This thesis complemented the existing knowledge through analyzing highly relevant questions concerning impersonal risks within five manuscripts. The following pages will summarize results on relevant research questions and discuss results collectively. This chapter concludes with insights and thoughts from personal discussions with participants, self-reflection on interdisciplinary research and future research ideas.

8.1 Summary

The research question of chapter 3 was: *“When do People take Action? The Importance of People’s Observation that Nature is changing for Pro-Environmental Behavior within the Field of Impersonal, Environmental Risk”*. Our results show that the biological method (visual assessment of infestation level), which was used to decide on sampling regions, helps to define a sample of participants, who show different extents in nature change and risk perception. The carried out mediation analysis reveals that the overall effect of nature change perception (observation that trees show damage) on communicative and active pro-environmental behavior is primarily mediated by their personal perception that the leafminer is a risk. This means for impersonal risks, that the mere observation of a nature change may be a possible tool to increase individual risk perception and throughout behavioral patterns related to nature changes. The results should serve to enhance understanding of how to communicate environmental issues in ways that promote the adoption of pro-environmental behavior.

Chapter 4 focused on *“Effects of Nature Change Perception and Media Reporting on Impersonal Risk Perception”*. It was shown that participants distinguish between the three different journalistic styles of articles (treatments) presented to them (tabloid, quality-press, popular/scientific magazine article). Furthermore, risk perception was rated higher after the treatment, indicating an effect of media on personal and societal risk perception. The popular/scientific article (highest quality, complexity & uncertainty) showed the lowest influence on change of risk perception, while the quality-press (medium quality, complexity & uncertainty) indicated the highest. We could show that prior experience through perceiving an environmental change varies prior risk perception and influences the effect media has. Participants, who have not observed the leaf damage prior to the survey showed a lower prior risk perception than those who have observed the damage more strongly. The treatment showed a stronger increase for those with low prior experience and risk perception. Overall, results emphasize the influence of mass media and the journalistic style on the communication of impersonal environmental risks. For impersonal risks, the results presented here show that different styles of journalistic articles can help to make the communication of impersonal environmental changes more effective for a broad audience, yet the individual perception that nature is changing is a strong determinant.

Chapter 5 deals with *“Analyzing the Existence and Relation of Optimistic Bias and First-Person Perception for an Impersonal Environmental Change”*. Two theoretical

concepts, indicating distortions in perceptions, were analyzed. An optimistic bias (OB) was illustrated for the risk concern of people. This means that people think that others are at a greater risk of being affected by the invasive leafminer than they themselves. The OB decreased for people living in an area subject to this impersonal nature risk. After the treatments, the second measured OB was neither significantly influenced by the impersonal risk's proximity nor the journalistic style of written article. A first-person perception (FPP) was found, indicating that participants show the tendency to think that they themselves get influenced more heavily by media coverage than other people. This FPP was neither influenced significantly by different journalistic styles nor the impersonal risk's proximity. Besides that, the relationship between OB and FPP was non-significant. For impersonal risks this shows that the selective biases in perceptions occur even though the risk is not threatening the public personally.

In chapter 6, the results of *“Factors Influencing Ecological Knowledge and its Effect on Information Processing and Communicative Behavior”* show, that education, age, and garden ownership influenced basic ecological knowledge of participants. Furthermore, prior knowledge did not directly influence behavioral intentions concerning the leafminer. However, knowledge influenced people’s “need for cognition” significantly, which then directly impacted behavior. Results reveal that also for impersonal risks, knowledge is a factor which influences behavior only indirectly, indicating that building educational campaigns on knowledge transfer is important, yet not sufficient to promote pro-environmental behavior.

In chapter 7, *“Comparing the Validity of a Representative versus Student Sample in Environmental, Impersonal Risk Research”*, our results indicate that surveys based on student samples can reveal relatively similar results compared to the results of a representative sample for some contents, in our case the optimistic bias or the effect of journalistic styles on risk perception, but it may also result in a total different outcome (first- person perception versus no distortion in perception). We conclude that for impersonal, environmental risks, it seems difficult to forecast a meaningful generalization when using student samples.

8.2 Collective Discussion

8.2.1 Risk perception

Among the factors known to influence personal risk perception is “prior experience”. The consequences of risks that can be seen, heard and felt—like a sunburn from overexposure

to the sun—create retained impressions which shape individual's subsequent behavior, and in their recounting, even that of others (Marx et al., 2007). Various studies presented in chapter 1 and 3 are based on environmental issues, such as hazards and environmental occurrences, with direct consequences or threats to people as case examples, including flooding (Terpstra et al., 2009) and hurricanes (Sattler et al., 2000). These studies reveal the relevance of personal experience for individual risk perception and behavioral intentions. Individuals who have undergone a direct experience of an event like flooding, will be more likely to be concerned and, therefore, are more highly motivated to display pro-environmental behavior (Spence et al., 2011). For impersonal risks, prior experience is possible through observing the nature change, in our case the damage to the leaves, but this observation is not associated with a personal threat. Nevertheless our results show that also for impersonal risks, the infestation level of a city and thus the objective proximity of a nature change seems to be influencing the individual observation that nature is changing (chapter 3). This nature change perception (prior experience without damage) is strongly correlated with individual risk perception of the leafminer (chapter 3, chapter 4) and thus in accordance to results based on personal risks: for impersonal risks the personal observation that nature is changing (prior experience) enhances risk perception. The level of infestation, which reflects the extent of an impersonal risk, also influences distortions in perceptions concerning the leafminer (chapter 5). Previous researchers have found that for personal risks people living in endangered areas, who had no first-hand experience, estimate risks to be smaller than those living farther away from the associated risk source (Heitz, Spaeter, Auzet, & Glatron, 2009). This could also be shown for impersonal risks. People tended to think that others are at a greater risk than they themselves (optimistic bias), especially if they lived in low infested areas (chapter 5). Our results are also in accordance to other impersonal risk research on climate change, where it was shown that most members of the American and Lithuanian public for instance consider climate change to be associated with a moderate risk, which is more likely to apply to people and places far away from them in space and time (Balzekiene, Butkeviciene, Rinkevicius, & Gaidys, 2009; Leiserowitz, 2006). As with risk perception, first-hand experience is also known to influence the degree of optimistic bias (Burger & Palmer, 1992; Van der Velde et al., 1994; Weinstein, 1980). Research on personal risks, such as earthquakes, found optimistic bias was not present directly after the earthquake, but only appeared several months later (Burger & Palmer, 1992; Helweg-Larsen, 1999). Individuals who experienced greater relative loss in the earthquake displayed the smallest optimistic bias. For impersonal risk, this trend is not as extreme as for personal risks (chapter 5). People living in cities that showed high infestation revealed smaller

extents of optimistic bias, yet the bias always occurred. Here the effects of personal damage or physical experience that occur for personal risks seem to differentiate the level of optimistic bias more strongly. Nevertheless a similar trend is observable for impersonal risks.

Besides, the possibility to perceive a nature change, the media are a major source of general and scientific information on environmental issues (Dunwoody & Peters, 1992; Schäfer & Schlichting, 2014). The media are “part of the very fabric of culture” (Hepp et al., 2010), implying that we perceive great parts of “the world” through the media, which provide information about issues that are not personally experienced by everyone. Risks are often first heard of and learned about through news media outlets (Vasterman et al., 2005). Research has shown that mass media reports influence people’s risk assessment (Kortenkamp & Basten, 2015; Stryker, Moriarty, & Jensen, 2008). Yet, research also shows that informing the public about environmental issues does not automatically raise environmental consciousness or enhance pro-environmental attitudes (De Haan, 1995). A study by Coleman (Coleman, 1993) reports about the influence of media for personal risks, even though other researcher claim that media information has a certain influence on the perception of general risks, but hardly on personal risks, as they are more related to interpersonal communication (Wahlberg & Sjoberg, 2000). We can add to those results by arguing that also for the concept of impersonal risks, mass media influence risk perception on a personal and societal level. Therefore, our results do not support the argumentation of Tyler and Cook, who stated that media has an influence on societal judgment, but not on a personal level judgment (Tyler & Cook, 1984). For the leafminer the written articles increased risk perception significantly (chapter 4), which implies that people built their opinion onto reporting about impersonal, environmental risks. Thus we find both, nature change perception and media, to influence risk perception (chapter 3, chapter 4, chapter 5, chapter 7), yet the individual perception of the nature change is determining how strong the influence of media is. Participants with higher personal perceptions of a nature change were less influenced by mass media. This is in contrast to our hypothesis that the media reporting would increase risk perception more strongly for participants who have been experiencing the nature change evoked by the leafminer (double dose effect). Similar to Weinstein we can add that direct experience provides greater vividness than solely hazard information (Weinstein, 1989). Therefore, it is understandable that the nature change perception is a more important factor contributing to risk perception of impersonal risks.

What do those results resemble for environmental scholars and practitioners? These results give hints on how environmental communication and education can be enhanced when

we need to increase risk sensitivity for truly impersonal risks, such as loss of biodiversity. Our research shows that both the individual perception that nature is changing and media are playing a role for the increase of (impersonal) risk perception on a personal and on a societal level (chapter 3, chapter 4). For impersonal risks, it was shown that the observation of a nature change, led to high levels of risk perception, which were not easy to be strongly influenced by information of written articles. Therefore, educational and political facilities need to increase their effort in terms of creating the possibilities for the public to perceive nature changes, even if they are not threatening the public personally, if they want to increase the risk assessment and lower optimistic bias of the public for environmental, impersonal risks (chapter 3, chapter 4, chapter 5). For environmental journalists or communication scholars, results also expressed that the quality-press article seems to be the best options to inform the public in order to increase risk perception regarding impersonal, environmental topics (chapter 4). The results are an important hint for environmental scientists as it shows, that keeping facts simple, but including qualitative elements in public discourse appears to be of higher success than trying to include more scientific terms and contents. Therefore we advise journalists and scientists to report about environmental problems in the proposed styles.

8.2.2 Behavioral intentions

As described in chapter 1 it is often found that people's past experience directly influenced their own behaviour when they were under threat (White, 1945). This apparently happens because attitudes based on direct experiences are more accessible in memory (Fazio & Zanna, 1981; Regan & Fazio, 1977). Individuals who have undergone a direct experience of an event like flooding, will be more likely to be concerned and, therefore, are stronger motivated to display pro-environmental behavior (Spence et al., 2011). Thus, risk perception has shown to directly affect active behavioral intentions, e.g. evacuation during hurricanes (Lazo, Bostrom, Morss, Demuth, & Lazrus, 2015). For impersonal risks our results indicate that the mere perception of a nature change (damage evoked by the leafminer) is already positively related to communicative (to inform others) and active behavioral intentions (to take part in collective leaf disposal) (chapter 3). Yet taking into account risk perceptions of participants showed, that these relationships are both mediated by individual risk perception. For impersonal risk, we argue in accordance to research on personal natural hazards, who state that people's risk perceptions are generally regarded as important factors of people's decisions to adjust to natural hazards (Terpstra et al., 2009) and we identified that also prior

experience, even though no personal threat is involved, shows indirect effect onto behavior, similar to what has been observed for personal risks.

Besides prior experience and risk perception, researchers and practitioners believed that education would automatically cause pro-environmental behavior (Fliegenschnee & Schelakovsky, 1998). This was often proven wrong. For example, two Swiss surveys found that environmental attitudes and knowledge related poorly directly to environmental behavior (Finger, 1994). Despite this, many organizations and institutions still build their campaigns to the greatest possible extent on knowledge transfer. For impersonal risks, ecological knowledge showed no direct influence on communicative behavior, yet influenced people's need for cognition, which influenced communicative behavior significantly. Thus, our structural equation model supports the research status also for impersonal risks (chapter 6). Even though knowledge is insufficient to produce most behavior changes, knowledge is necessary, as it is known to affect our cognitions and attitudes.

Generally we have found that for impersonal risks prior experience, mediated through risk perception, influences behavior and that knowledge shows to have an indirect effect. These results are similar to those of personal risks. Yet we also see that self-reported real behavior for taking part in collective leaf disposal did not exist, even though some citizens indicated behavioral intentions. This again might differentiate personal from impersonal risks. Concerning impersonal risks, even though the nature change can be observed and risk perception and behavioral intentions might be high, there seems to be missing motivation or possibilities which induce a rapid and frequent change in behavior. Besides the fact that behavior change might be even more difficult if the need to change behavior quickly is not as urgent as it might be when being confronted with personal risks, it could be possible that information and support needed from cities officials on the implementation of control measures is insufficient. Thus change in behavior would not only depend on the individual motivation, but also on cities offers and support. Participants told us, that the offer of information from the cities about *Cameraria ohridella* itself and the options of how to fight it are quite few. The majority had no information on where to bring the collected leaves and had to become very active calling the regional governments. Also within the timeframe of our survey only very few organized collective leaf disposals took place, which were not widely announced. It was therefore hard for participants of our survey to take part – if offers are so few. We recommend for impersonal risks, that cities should organize and announce collective leaf disposals more widely, as some of their citizens show intentions to take part, even though

they are not personally threatened by this invasive species. Yet the effort to organize a private disposal seems to be too high for this impersonal risk.

8.2.3 Methodological evidence

When discussing results derived through a representative sample, comparing it to research based on student samples might be difficult. Yet, quite a large amount of research published in academic journals has been decried as the “science of the sophomore” because of the prevalence of using students as research subjects (James & Sonner, 2001). It is not new, that the heavy reliance on college or student sampling receives a lot of criticism (Ferber, 1977; Wells, 1993). Concerning impersonal risks, comparing results derived from a student and a representative sample indicate that student samples can reveal relatively similar results compared to the results of a representative sample for some contents, in our case the optimistic bias (chapter 5, chapter 7) or the effect of journalistic styles on risk perception (chapter 4, chapter 7), but it may also result in a total different outcome. In chapter 5 we have identified a first-person perception, i.e. the tendency of people to think that they themselves get influenced more heavily by media coverage than other people. Our results accord with Lin, who also recorded first-person perception in the context of environmental communication (Lin, 2013). Yet when analyzing this theoretical concept based on the student sample, we see that there is no significant distortion, thus representing a totally different result (chapter 7). This is a meaningful result, of which environmental scholars need to pay attention to. For comparing research results for a case study on an environmental, impersonal risk we may conclude that we can not argue in favour of a generalisation when using student samples. Standard deviations were not always uniformly smaller for student samples when being compared to representative samples. Also the scales we used for risk perception showed higher internal reliability for the representative sample. If an overall representative sample is not possible, using a small control group to identify potential strong differences should be used in addition to the commonly used student samples.

8.3 Thought-provoking impulses

In the second year of the thesis, 11 participants in Bavaria and Schleswig-Holstein were visited. We organized a collective leaf disposal, walked through their cities and discussed the issue of the leafminer and invasive species in general with their families, neighbors and friends. The intention was to get more personal background information.

Additionally we were able to see, whether measures, like collecting leaves, really took place and to give them advice of what they could change. Particularly striking was that out of the seven people who thought that they have infested chestnut trees, only four trees were actually infested with the horse chestnut leafminer *Cameraria ohridella*. One tree showed a typical leaf fungus (*Guignardia aesculi*) pattern, two others showed characteristics as if infested by the bacteria *Pseudomonas syringae*. Nevertheless, it is of advantage that the control measures proposed against *C. ohridella*, are also efficiently working for the leaf fungus. Further literature also states that the differentiation is difficult for the public (Zimmermannová-Pastirčáková, 2002). Trees that have a *Pseudomonas* infection must be cut according to previous research, because they may sooner or later die and endanger people as branches may fall off (Kennelly, Cazorla, de Vicente, Ramos, & Sundin, 2007). Since our written articles have described only the infestation by the leafminer and did not show any detailed pictures, this perhaps explains, why people thought their trees were infected by the horse chestnut leafminer, even though other diseases, which patterns may appear to be similar to a non-expert, were occurring. Apparently, many people were not able to distinguish between the real environmental change described in the written articles, the infestation by the horse chestnut leafminer, and brown colored patterns on leaves evoked through other diseases, such as the leaf fungus or bacteria. This might be a hint, that only reporting about the appearance of a disease might not be good and adequate enough for the laymen to identify a specific nature change. For this thesis this fact does not matter, yet for other environmental changes which may have similar appearances, e.g. different invasive plant species, different control measures may serve different functions. Detailed descriptions and including pictures may help.

Another aspect is that through personal visits, the high amount of work for collecting leaves to control populations became strongly apparent. Several dozen bags with collected leaves need to be driven to a special institution, where they will be burned. This work needs to be accomplished by owners for many years. And often the success is smaller than expected. Another common problem is the type of relationship of neighbors. Hedges on adjacent properties with neighbors who do not want to dispose the foliage of foreign trees cause the problem that the work of the tree owner often shows little effect in the coming years, as leaves are left in hedges or the garden of the neighbor. This frustrated participants and may hint to another reason why often pro-environmental behavior might be abandoned, as the public does not actively experience a positive effect of their change in behavior. Concerning eating less chocolate, one will notice at some point that the own body weight is lowered. Concerning many impersonal environmental changes, such as loss of species, it might be difficult to

experience success of pro-environmental behavior. This discovery provides thus another hint, that besides offering activities where people may experience impersonal risks, it is also then needed to create information and spaces where success of pro-environmental behavior is shown. One city had signposts, explaining why leaves of chestnut trees are collected every year and how green spaces would look if this would not be done. Citizens were thus actively collecting leaves to keep this status, while having in mind the pictures of how trees appeared in the previous years.

8.4 Discussing interdisciplinary research

As discussed already in the introduction, researchers become aware that complex issues, like environmental changes, are better investigated and solved in an interdisciplinary manner. The magnitude of human impact on the planet's ecological systems becomes ever more apparent, thus encouraging scientists to study connections between these systems, human health, the economy, social justice and even national security (Lubchenco, 1998). This thesis connected methods from the natural and social sciences to investigate human attitudes, perceptions and behavior towards the environmental impersonal risk of the horse chestnut leafminer. I will shortly discuss and reflect the opportunities and challenges of interdisciplinary research (in our case: biology and communication science) based on the research and the cooperation within the projects for this thesis. It should be noticed at the beginning, that there is no final term conceptualization of the terms inter- and transdisciplinarity (Aboelela et al., 2007; Bogner, Kastenhofer, & Torgersen, 2010). We understood interdisciplinary research as process involving at least two disciplines aiming at "integrating their insights to construct a more comprehensive understanding" (Repko, 2012).

The starting point of our research project between biology and communication science was that scientific insights into current changes in nature are of relevance to society and contain central information about the responsibility of the individual in dealing with and in nature. The main interest was to analyze the concept of impersonal risk. The horse chestnut leafminer was chosen as case example, as damage is strongly observable. As described in chapter 2, the infestation is varying in different cities of Germany. We were able to show that the methods of natural scientists ideally complemented to recruitment methods of communication scientists in order to find a sample of participants both representative for the German population and at the same time offering a sample in which participants showed different levels of perceptions. Due to the primary selection of the areas and classification of the cities into areas of high and low infestation, we argued that in areas with a high, obvious

damage (high infestation), citizens would also notice this environmental change more clearly (higher personal nature change perception), compared to areas with low infestation. This was later on proven to be correct (chapter 3). Biological methods could thus help to ensure that there would be different groups of participants who would perceive environmental damage differently. Thus, the communication science was able to recruit specifically in these areas. Further, the biologists had the advantage to have the guarantee, that the social science methods were used appropriately through valid survey instruments. In the research field of ecology, the use of questionnaire has increased over the last decade (White, Jennings, Renwick, & Barker, 2005). This is because questionnaires are seen as suitable tools for gaining knowledge on stakeholders' or locals' perceptions, in order to involve them later on in the decision-making process, e.g. concerning human-wildlife interaction (White et al., 2005). As White points out, the number of questionnaires in ecology increased five-fold from 1991 to 2003. Yet there are several shortcomings when reviewing the applications of those methods. Almost a third of the questionnaires examined by White did not explain the sampling procedure, which is a necessity, as "any conclusions arising from the questionnaire have little value because it is not possible to evaluate the reliability of the data or the degree to which the respondents are representative of the target population" (White et al., 2005). Further White points out that in one third of the questionnaires data was not analyzed statistically, but rather only frequencies were reported. One of the reasons may be that there exists insecurity of how to work with these kinds of data and thus the decision is not to implement any statistical evaluation. Here biologists can profit from interdisciplinary work and learn on handling data of questionnaires appropriately.

Besides the fact described in the introduction (chapter 1), that interdisciplinary research is needed to solve complex conflicts and often urged in grant proposals, many researchers refer to the validation of the interdisciplinary research process and its outcomes as a challenging topic, expressing their feelings in words such as "problematic", "unclear", "opinion-driven" (Mansilla, 2006). Yet, even though we have also made the experience that publishing processes might sometimes be difficult (e.g. one journal wants more information about the leafminer and less on social theoretical constructs, the other demands exactly a different focus), we do not think that it is more difficult than in one-disciplinary research or among researchers with different cultural backgrounds: scientific tools and methods in both disciplines have to be correctly validated, described, applied and evaluated. However we agree, that interdisciplinary work might be difficult to be correctly rated and evaluated by reviewers, as they might be specialists in one field, but not another.

We have also made the experience that structures of manuscript or wordings may be differently used in the disciplines, but when managing the challenges of communication between disciplines, the results then can be used in both fields and this is what counts in our perspectives. In our case: the results on the importance of observation that nature is changing, the effects of media and the indirect effect of knowledge found for impersonal risks, helps biologists, conservationists and politicians to develop more effective ways to foster risk perception of people facing an impersonal, environmental risk (chapter 3, chapter 4, chapter 5, chapter 6, chapter 7). Those results are further interesting for researchers in social sciences as they add to existing research about personal risks.

8.5 Future research

During writing the thesis, a few interesting follow-up research ideas developed. To further complement our findings, the effects of an environmental personal risk and an environmental impersonal risk should be directly compared. As model organism for a personal risk the invasive species *Heracleum giganteum* could be used. This plant species occurs worldwide (also in Germany) and it negatively influences people's health through activating phototoxic reactions on the skin due to its content of various furocoumarins (Karimian-Teherani, Kinaciyan, & Tanew, 2008). Another invasive plant species, which does not cause harm to humans health, could be used as impersonal risk. Regions in Germany with high and low occurrence of both species would be investigated and as shown in this thesis, questionnaires could be carried out analyzing the relation of nature change perception (including personal health damage), risk perception, behavioral intention, and real behavior. The differences in effect sizes could be directly compared.

Besides that, it would be very interesting to analyze how the present general media coverage of an environmental change within a distinct region influences risk perception. For this, the reporting of the case organisms need to be investigated for the past one to two years for different regions (showing either low or high infestation). This analysis could show whether media coverage is varying (e.g. quantity and quality) in dependency of the infestation level of the selected areas and how the reporting influences nature change and risk perception of the public. This could be either done for the horse chestnut leafminer or in combination with analyzing an impersonal and a personal invasive species.

Another interesting aspect for biologists would be to analyze why specific invasive species are perceived and covered by media in a positive way, while others are always reported as threat. Many invasive species are often regarded as "beautiful" or "special" and

the distribution is even often promoted through taking care of invasive animal species or even planting invasive plant species in private gardens. Examples where these strong polarizations could be analyzed would be e.g., the raccoon (*Procyon lotor*) or the Himalayan balsam (*Impatiens glandulifera*). For both species a quick look into media reporting shows that there are citizens in Germany that take care of raccoons or plant the Himalayan balsam, and there is the strong opposition, which shoots the raccoons whenever possible and destroys the Himalayan balsam. Understanding the personal background evoking this polarization and its dependency from knowledge, nature change perception, personal damage, and media reporting would be of great interest. A second step would be to investigate people's real behavior. This could be done through private visits or cooperation with hunters.

8.6 Conclusion

Overall, my thesis shows that many relations of impersonal risks are similar to those found for personal risks. The individual perception that nature is changing (prior experience without personal damage) positively influences risk perception and thus pro-environmental behavior. Media has an additional positive effect, especially if people have not observed the damage caused by the horse chestnut leafminer before. Further, knowledge shows no direct effect on pro-environmental behavior. The implementations of many active behavior changes seem to be more difficult regarding impersonal risks than personal risks. Possible explanations might be the lack of motivation (if a risk is not a direct threat), the lack in possibilities and information by regional governments, or the fact that positive outcomes are not perceived quickly. Further, we argue against a generalization of results when using student samples. Based on these findings, different environmental communication strategies should be expected. The direct observation is a crucial factor for risk perception and pro-environmental behavior and media is adding positively through reporting in a credible and informative way. I urge practitioners to (re-)organize environmental education and communication programs by taking into account the importance of individual experiences through observations of impersonal, environmental risks and an adequate communication of information through the proposed quality level. Future studies need to compare an impersonal and an already personal environmental change directly with each other and should investigate how to bridge the gap to real pro-environmental behavior. Further it is of great interest to investigate how broad media coverage influences and polarizes perceptions, attitudes and behavior towards invasive species and other impersonal risks.

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Appendix A: Questionnaires

1) First wave – representative sample

Note: The student questionnaire was almost identically with the first wave of the DFG-project. A few irrelevant questions were deleted (Q3, Q29, Q30, Q32), a control treatment added (Fig. 7d), and two questions were rephrased (see appendix A: Q31 - media usage in minutes instead of categories; Q37 - postal code instead of city). Further, students were not asked whether they would like to have some biologist visit them, as we argued that not many students would own a garden with chestnut trees.

2) Second wave – representative sample

Liebe Studienteilnehmer,

vielen Dank, dass Sie sich die Zeit nehmen, an dem gemeinsamen Forschungsprojekt der Münchner Universitäten teilzunehmen. Ziel dieser Studie ist es, die Wahrnehmung zu Umweltveränderungen in der Bevölkerung zu erforschen. Sie wurden nach einem Zufallsprinzip als Teilnehmer für unsere Studie ausgewählt. Ihre Teilnahme ist von höchster Wichtigkeit für das Gelingen dieser Forschungsarbeit.

Mit den folgenden Fragen möchten wir Ihre Meinung zu Umweltveränderungen, Pflanzenschädlingen sowie der Medienberichterstattung darüber erfahren. Dazu werden wir Ihnen im Laufe dieser Umfrage einen kurzen Zeitungsartikel zu lesen geben. Die Beantwortung der Fragen wird etwa 15 Minuten in Anspruch nehmen. Bitte beantworten Sie die Fragen möglichst vollständig und spontan.

Die Auswertung des Fragebogens erfolgt gemäß höchsten wissenschaftlichen Standards. Unsere Verarbeitung sichert Ihre Anonymität.

Bei Fragen zu dieser Studie wenden Sie sich bitte an Prof. Dr. Hans-Bernd Brosius von der LMU München unter professor.brosius@ifkw.lmu.de

Vielen herzlichen Dank für Ihre Mithilfe!



1. Kümmern Sie sich selbst um einen Garten, z.B. eigener Garten, Schrebergarten, Garten von Familienangehörigen, Freunden oder Verwandten?

	ja	nein
Ich kümmere mich um einen Garten	<input type="checkbox"/>	<input type="checkbox"/>

(Filter: Falls Teilnehmender sich um einen Garten kümmert)

2. Wie häufig verbringen Sie im Sommer Zeit in diesem Garten?

Täglich	Mehrmals die Woche	Mehrmals im Monat	Seltener
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3. Gerne würden wir mehr über das Interesse an Umweltthemen erfahren.

Was trifft für Sie persönlich zu?

	Trifft voll und ganz zu	Trifft eher zu	Teils/teils	Trifft weniger zu	Trifft überhaupt nicht zu	Kann ich nicht beurteilen
Das Problem des Klimawandels wird von Forschern stark übertrieben	<input type="checkbox"/>	<input type="checkbox"/>				
Ich denke oft darüber nach, dass ich Schadstoffe in meinen Körper aufnehme	<input type="checkbox"/>	<input type="checkbox"/>				
Wenn ich an unsere Umwelt denke, bin ich um meine Zukunft besorgt	<input type="checkbox"/>	<input type="checkbox"/>				
Es macht mir Angst, dass an vielen Orten Gift- oder Atommüll gelagert wird	<input type="checkbox"/>	<input type="checkbox"/>				
Ich frage mich, ob in meiner Wohnung oder in meinem Haus Asbest oder ähnliches	<input type="checkbox"/>	<input type="checkbox"/>				
Die Wissenschaft ist in der Lage, Umweltprobleme zu lösen	<input type="checkbox"/>	<input type="checkbox"/>				
Der Klimawandel macht mir Angst	<input type="checkbox"/>	<input type="checkbox"/>				
Je mehr Informationen ich über Umweltbelastungen bekomme, desto unsicherer fühle ich mich	<input type="checkbox"/>	<input type="checkbox"/>				

4. Wie oft sehen Sie einen Kastanienbaum?

Nie	Selten	Häufig	Täglich	Ich bin mir nicht sicher, wie ein Kastanienbaum aussieht
<input type="checkbox"/>				

Dies ist ein Bild von einem Kastanienbaum und seinen Blättern und Blüten



5.

	ja	nein	Weiß nicht
Besitzen Sie selbst einen oder mehrere Kastanienbäume?	<input type="checkbox"/>	<input type="checkbox"/>	
Besitzen Freunde/Familienangehörige einen Kastanienbaum?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Besitzen andere Personen aus Ihrem weiteren Bekanntenkreis einen Kastanienbaum?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

(Filter: Jeweils falls man selbst/Freunde & Familie/Bekannte einen Kastanienbaum besitzen)

6.

	ja	nein	Weiß nicht
Verfärben sich die Blätter Ihrer Kastanie(n) im Sommer frühzeitig braun?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Verfärben sich die Blätter der Kastanie(n) Ihrer Freunde /Familienangehörigen im Sommer frühzeitig braun?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Verfärben sich die Blätter der Kastanie(n) Ihrer Bekannten im Sommer frühzeitig braun?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

7. Was ist Ihnen bis jetzt an Kastanienbäumen aufgefallen?

Wie häufig ist Ihnen Folgendes aufgefallen?	sehr häufig	häufig	hin und wieder	selten	gar nicht
Die Blätter der Kastanie färben sich schon im Sommer braun	<input type="checkbox"/>				
Die Blätter der Kastanie fallen früher ab als gewöhnlich	<input type="checkbox"/>				
Kastanienbäume blühen nicht mehr	<input type="checkbox"/>				

8. Bitte beantworten Sie die beiden folgenden Fragen.

	ja	nein
Haben Sie von einem oder mehreren Gründen für die frühere Braunfärbung der Blätter der Kastanie gehört?	<input type="checkbox"/>	<input type="checkbox"/>
Haben Sie von einem Insekt namens „Kastanienminiermotte“ gehört?	<input type="checkbox"/>	<input type="checkbox"/>

Es gibt verschiedene Gründe für eine verfrühte Braunfärbung der Blätter der Kastanien. Die „Kastanienminiermotte“ kann die Braunfärbung auslösen. Nachfolgend wird diese vereinfacht „Kastanienmotte“ genannt.

Im folgenden Teil stellen wir Ihnen einige Fragen zur Kastanienmotte. Es ist durchaus kein Problem, wenn Sie vorher noch nie von diesem Tier gehört haben. Es geht bei den folgenden Fragen nur um Ihre persönliche Einschätzung. Im Laufe der Befragung erhalten Sie noch genauere Hintergrundinformationen zur Kastanienmotte.

9. Was trifft für Sie persönlich am ehesten zu

	Trifft voll und ganz zu	Trifft eher zu	Teils/teils	Trifft weniger zu	Trifft überhaupt nicht zu	Kann ich nicht beurteilen
Artikel zu Pflanzenschädlingen (wie z.B. der Kastanienmotte) überfliege ich nur oberflächlich	<input type="checkbox"/>	<input type="checkbox"/>				
Wenn ich auf einen Artikel über die Kastanienmotte stoße, lese ich ihn gründlich	<input type="checkbox"/>	<input type="checkbox"/>				
Es ist mir wichtig, alle Fakten zur Kastanienmotte im Detail zu kennen	<input type="checkbox"/>	<input type="checkbox"/>				
Ich möchte mehr über die Kastanienmotte erfahren	<input type="checkbox"/>	<input type="checkbox"/>				

10. Für wie wahrscheinlich halten Sie es, dass in nächster Zeit...

	Sehr wahrscheinlich	Eher wahrscheinlich	Teils/teils	Eher unwahrscheinlich	Unwahrscheinlich
... die Kastanienmotte in Ihrer direkten Nachbarschaft , also in Ihrem Stadtteil oder in Ihrer Ortschaft, vorkommt	<input type="checkbox"/>				
... die Kastanienmotte verstärkt in ihrem Landkreis vorkommt	<input type="checkbox"/>				
... die Kastanienmotte verstärkt in anderen Teilen Deutschlands vorkommt	<input type="checkbox"/>				

11. Blattverfärbungen, die aus einem Befall mit der Kastanienmotte entstanden sind, treten in verschiedenen Regionen in Deutschland unterschiedlich stark auf. Bitte schildern Sie uns anhand der nächsten Fragen Ihren Eindruck!

Wie schätzen Sie die Probleme ein, die die Kastanienmotte mit sich bringt?

	Sehr großes Problem	Großes Problem	Mittelmäßiges Problem	Kleines Problem	Kein Problem
Die Kastanienmotte ist in meiner direkten Nachbarschaft , also in meinem Stadtteil oder in meiner Ortschaft, ein...	<input type="checkbox"/>				
Die Kastanienmotte ist in meinem Landkreis ein...	<input type="checkbox"/>				
Die Kastanienmotte ist in anderen Teilen Deutschlands ein...	<input type="checkbox"/>				

12. In wie weit stimmen Sie folgenden Aussagen zu:

	Stimme voll und ganz zu	Stimme eher zu	Teils/teils	Stimme weniger zu	Stimme überhaupt nicht zu
Die Kastanienmotte ist ein finanzielles Problem	<input type="checkbox"/>				
Die Kastanienmotte ist ein ästhetisches Problem	<input type="checkbox"/>				
Die Kastanienmotte ist ein Problem für die Natur / das Ökosystem	<input type="checkbox"/>				

13. Man kann ja ganz unterschiedlicher Meinung sein. Sie können in der nächsten Frage in Ihrer Meinung zwischen der Aussage auf der linken und der Aussage auf der rechten Seite tendieren.

Welcher der Aussagen stimmen Sie eher zu?

| | <input type="checkbox"/> | |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--|
| Ich bin besorgt, dass die Kastanienbäume absterben | <input type="checkbox"/> | Die Kastanienbäume erholen sich schon wieder |
| Es macht mich betroffen, wenn die Blätter der Kastanie oft schon frühzeitig abfallen | <input type="checkbox"/> | Irgendwann fallen die Blätter auch so ab |
| Es macht mich ärgerlich, wenn Kastanienbäume aufgrund ihres unschönen Aussehens im Stadtbild gefällt werden | <input type="checkbox"/> | Kastanienbäume müssen ohnehin aus Altersgründen gefällt werden |

14.

	ja	nein
Haben Sie von Maßnahmen zur Bekämpfung der Kastanienmotte gehört?	<input type="checkbox"/>	<input type="checkbox"/>
Haben Sie selbst Maßnahmen gegen die Kastanienmotte unternommen?	<input type="checkbox"/>	<input type="checkbox"/>

15. Unabhängig davon was Sie bereits wissen oder gehört haben- was hilft Ihrer Meinung nach, gegen den Befall der Kastanienbäume?

Sie können hier mehrere Möglichkeiten ankreuzen.

<input type="checkbox"/>	Laub sammeln und entsorgen
<input type="checkbox"/>	Pflanzenschutzmittel/Insektizide
<input type="checkbox"/>	Das Fällen der betroffenen Bäume
<input type="checkbox"/>	Natürliche Fressfeinde
<input type="checkbox"/>	Nichts davon

(Filter: Falls Teilnehmender selbst Maßnahmen unternommen hat)

16. Was haben Sie bereits als Maßnahme gegen die Kastanienmotte unternommen?

	ja	nein
Ich habe in meinem Garten Laub gesammelt und entsorgt	<input type="checkbox"/>	<input type="checkbox"/>
Ich habe an kollektiven Laubsammelaktionen teilgenommen	<input type="checkbox"/>	<input type="checkbox"/>
Ich habe biologische/chemische Pflanzenschutzmittel angewendet	<input type="checkbox"/>	<input type="checkbox"/>
Ich habe Laubsammelaktionen initiiert	<input type="checkbox"/>	<input type="checkbox"/>

(Filter: Falls Teilnehmender schon vorher von der Kastanienminiermotte gehört hat)

17. Was haben Sie bisher unternommen?

	ja	nein
Ich habe mich genau über die Kastanienmotte informiert	<input type="checkbox"/>	<input type="checkbox"/>
Ich habe andere über die Kastanienmotte informiert	<input type="checkbox"/>	<input type="checkbox"/>
Ich habe mich an das zuständige Amt (z.B. das Gartenbauamt) gewandt	<input type="checkbox"/>	<input type="checkbox"/>

21. Einmal abgesehen von der neutralen Gestaltung des Textes, wenn Sie nur an den Inhalt des Artikels denken: In welchem Bereich hätten Sie den Artikel am ehesten vermutet?

- Boulevardzeitung (wie BILD / AZ)
- Süddeutsche Zeitung / Die Zeit / FAZ / Die Welt
- Populärwissenschaftliche Zeitschrift (wie P.M. / GEO)

22. Medien, wie Zeitung und Fernsehen, berichten zunehmend über die Kastanienmotte. Man kann es ja nie genau wissen, aber was denken Sie über die folgenden Aussagen?

	Stimme voll und ganz zu	Stimme eher zu	Teils/teils	Stimme weniger zu	Stimme überhaupt nicht zu	Kann ich nicht beurteilen
Berichte haben einen starken Einfluss auf...						
... meine Einschätzung über die Kastanienmotte	<input type="checkbox"/>	<input type="checkbox"/>				
... die Einschätzung meines Freundes- und Familienkreises	<input type="checkbox"/>	<input type="checkbox"/>				
... die Einschätzung der Menschen in meinem Landkreis	<input type="checkbox"/>	<input type="checkbox"/>				
... die Einschätzung der breiten Bevölkerung	<input type="checkbox"/>	<input type="checkbox"/>				

(Zufällige Zuteilung von Frage 23a oder 23b)

23a. Bitte lesen Sie folgende Aussage durch:

Aufgrund von Medienberichten zu Umweltthemen, wie der Kastanienmotte, bildet man sich oft Meinungen und hinterher stellt sich heraus, dass alles ganz anders ist

	Voll und ganz zu	Eher zu	Teils/teils	Weniger zu	Überhaupt nicht zu
Diese Aussage trifft auf...					
...Mich...	<input type="checkbox"/>				
...Menschen in meinem Familien- und Freundeskreis...	<input type="checkbox"/>				
...Menschen in meinem Landkreis...	<input type="checkbox"/>				
...die Allgemeinheit der Bevölkerung...	<input type="checkbox"/>				

(Zufällige Zuteilung von Frage 23a oder 23b)

23b. Bitte lesen Sie folgende Aussage durch:

Medienberichte helfen einem, bessere Urteile über Umweltangelegenheiten (wie der Kastanienmotte) zu bilden

Diese Aussage trifft auf...	Voll und ganz zu	Eher zu	Teils/teils	Weniger zu	Überhaupt nicht zu
...Mich...	<input type="checkbox"/>				
...Menschen in meinem Familien- und Freundeskreis...	<input type="checkbox"/>				
...Menschen in meinem Landkreis...	<input type="checkbox"/>				
...die Allgemeinheit der Bevölkerung...	<input type="checkbox"/>				

24. Nachdem Sie den Artikel gelesen haben, für wie wahrscheinlich halten Sie es, dass in nächster Zeit...

	Sehr wahrscheinlich	Eher wahrscheinlich	Teils/teils	Eher unwahrscheinlich	Unwahrscheinlich
... die Kastanienmotte in Ihrer direkten Nachbarschaft , also in Ihrem Stadtteil oder in Ihrer Ortschaft, vorkommt	<input type="checkbox"/>				
... die Kastanienmotte verstärkt in ihrem Landkreis vorkommt	<input type="checkbox"/>				
... die Kastanienmotte verstärkt in anderen Teilen Deutschlands vorkommt	<input type="checkbox"/>				

25. Wie schätzen Sie die Probleme ein, die die Kastanienmotte mit sich bringt?

	Sehr großes Problem	Großes Problem	Mittelmäßiges Problem	Kleines Problem	Sehr kleines Problem
Die Kastanienmotte ist in meiner direkten Nachbarschaft , also in meinem Stadtteil oder in meiner Ortschaft, ein...	<input type="checkbox"/>				
Die Kastanienmotte ist in meinem Landkreis ein...	<input type="checkbox"/>				
Die Kastanienmotte ist in anderen Teilen Deutschlands ein...	<input type="checkbox"/>				

(Filter: Falls Teilnehmender selbst, Freunde/Verwandte oder Bekannte Kastanienbäume besitzen)

26. Wie sehen Ihre Pläne aus, um mit dem Befall der Kastanie umzugehen?

	Sehr wahr- scheinlich	Eher wahr- scheinlich	Teils/ teils	Eher unwahr- scheinlich	Sehr unwahr- scheinlich
Ich habe vor, im Herbst Laub in meinem Garten zu sammeln	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ich habe vor, biologische/chemische Pflanzenschutzmittel anzuwenden	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

27. Wie sehen Ihre Pläne aus, um mit dem Befall der Kastanie umzugehen?

	Sehr wahr- scheinlich	Eher wahr- scheinlich	Teils/ teils	Eher unwahr- scheinlich	Unwahr- scheinlich
Ich habe vor...					
...an kollektiven Laubsammelaktionen teilzunehmen	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
...Laubsammelaktionen zu initiieren	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
...mich genauer zu diesem Thema informieren	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
...andere über die Kastanienmotte zu informieren	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
...die Kastanien in meinem Umfeld genauer auf eine verfrühte Braunfärbung zu beobachten	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
...mich an das zuständige Amt (z.B. an das Gartenbauamt) zu wenden	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

28. Was hilft Ihrer Meinung nach, gegen den Befall der Kastanienbäume?

Sie können hier mehrere Möglichkeiten ankreuzen.

<input type="checkbox"/>	Laub sammeln und entsorgen
<input type="checkbox"/>	Pflanzenschutzmittel/Insektizide
<input type="checkbox"/>	Das Fällen der betroffenen Bäume
<input type="checkbox"/>	Natürliche Fressfeinde
<input type="checkbox"/>	Nichts davon

32. Wo arbeiten Sie meistens:

- Überwiegend in geschlossenen Räumen
- Überwiegend im Freien
- Teils/Teils

33. In wie weit sind Sie in einem Umweltschutzverein, einer Organisation oder einer örtlichen Naturschutzinitiative beteiligt.

Ich...	ja	nein
... spende	<input type="checkbox"/>	<input type="checkbox"/>
... bin Mitglied	<input type="checkbox"/>	<input type="checkbox"/>
... engagiere mich aktiv	<input type="checkbox"/>	<input type="checkbox"/>

34. Zuletzt bitten wir Sie um einige Angaben zu Ihrer Person:

Bitte tragen Sie Ihr Geburtsjahr in den Kasten rechts ein

Ich bin im folgendem Jahr geboren (z.B. 1980)

35. Bitte geben Sie Ihr Geschlecht an:

- Männlich
- Weiblich

36. Bitte geben Sie Ihren höchsten allgemeinen Schulabschluss an:

- Kein allgemeiner Schulabschluss
- Haupt/Volksschulabschluss
- Realschulabschluss (Mittlere Reife)
- Abitur/Fachabitur
- Hochschulabschluss/Fachhochschulabschluss

37. Wie heißt die Stadt oder Gemeinde in der Sie wohnen?

Im Rahmen dieser Studie bieten Mitarbeiter der Technischen Universität München an, Ihre Kastanie oder Kastanien in Ihrem Umfeld direkt vor Ort zu untersuchen, Ihnen für Fragen zur Verfügung zu stehen und Ihnen eine Einschätzung der Situation zu geben. Wenn Sie daran Interesse haben, hinterlegen Sie bitte eine E-Mailadresse oder Telefonnummer, unter der wir Sie zur Terminvereinbarung im September kontaktieren dürfen.

Diese Kontaktdaten werden nur zur einmaligen Kontaktaufnahme im Rahmen dieser Studie verwendet und selbstverständlich nicht an Dritte weitergegeben.

	<input type="checkbox"/> Nein, ich möchte nicht von der TU München kontaktiert werden.
--	--

Vielen Dank für Ihre Teilnahme!

Wir möchten uns ganz herzlich für Ihre Mithilfe bedanken.

Bei Fragen zu dieser Studie wenden Sie sich bitte an Prof. Hans-Bernd Brosius von der LMU München unter:

professor.brosius@ifkw.lmu.de

Ihre Antworten wurden gespeichert, Sie können das Browser-Fenster nun schließen.

Liebe Studienteilnehmer,

vielen Dank, dass Sie uns weitere 5 Minuten Ihrer Zeit schenken, um ein paar zusätzliche Fragen im Rahmen des gemeinsamen Forschungsprojektes der Münchner Universitäten zu beantworten.

Bitte beantworten Sie die Fragen möglichst vollständig und spontan. Die Auswertung des Fragebogens erfolgt gemäß höchsten wissenschaftlichen Standards. Unsere Verarbeitung sichert Ihre Anonymität.

Bei Fragen zu dieser Studie wenden Sie sich bitte an Prof. Dr. Hans-Bernd Brosius von der LMU München unter professor.brosius@ifkw.lmu.de

Vielen herzlichen Dank für Ihre Mithilfe!



1. Was ist Ihnen diesen Sommer an Kastanienbäumen aufgefallen?

	sehr häufig	häufig	hin und wieder	selten	gar nicht
Die Blätter der Kastanie färben sich schon im Sommer braun	<input type="checkbox"/>				
Die Blätter der Kastanie fallen früher ab als gewöhnlich	<input type="checkbox"/>				

2. Für wie wahrscheinlich halten Sie es, dass in nächster Zeit...

	Sehr wahrscheinlich	Eher wahrscheinlich	Teils/teils	Eher unwahrscheinlich	Unwahrscheinlich
... die Kastanienmotte in Ihrer direkten Nachbarschaft , also in Ihrem Stadtteil oder in Ihrer Ortschaft, vorkommt	<input type="checkbox"/>				
... die Kastanienmotte verstärkt in ihrem Landkreis vorkommt	<input type="checkbox"/>				
... die Kastanienmotte verstärkt in anderen Teilen Deutschlands vorkommt	<input type="checkbox"/>				

3. Blattverfärbungen, die aus einem Befall mit der Kastanienmotte entstanden sind, treten in verschiedenen Regionen in Deutschland unterschiedlich stark auf. Bitte schildern Sie uns anhand der nächsten Fragen Ihren Eindruck!

Wie schätzen Sie die Probleme ein, die die Kastanienmotte mit sich bringt?

	Sehr großes Problem	Großes Problem	Mittelmäßiges Problem	Kleines Problem	Kein Problem
Die Kastanienmotte ist in meiner direkten Nachbarschaft , also in meinem Stadtteil oder in meiner Ortschaft, ein...	<input type="checkbox"/>				
Die Kastanienmotte ist in meinem Landkreis ein...	<input type="checkbox"/>				
Die Kastanienmotte ist in anderen Teilen Deutschlands ein...	<input type="checkbox"/>				

4. Man kann ja ganz unterschiedlicher Meinung sein. Sie können in der nächsten Frage in Ihrer Meinung zwischen der Aussage auf der linken und der Aussage auf der rechten Seite tendieren.

Welcher der Aussagen stimmen Sie eher zu?

| Ich bin besorgt, dass die Kastanienbäume absterben | <input type="checkbox"/> | Die Kastanienbäume erholen sich schon wieder |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--|
| Es macht mich betroffen, wenn die Blätter der Kastanie oft schon frühzeitig abfallen | <input type="checkbox"/> | Irgendwann fallen die Blätter auch so ab |
| Es macht mich ärgerlich, wenn Kastanienbäume aufgrund ihres unschönen Aussehens im Stadtbild gefällt werden | <input type="checkbox"/> | Kastanienbäume müssen ohnehin aus Altersgründen gefällt werden |

5.

	ja	nein
Kümmern Sie sich um einen Garten mit Kastanienbaum?	<input type="checkbox"/>	<input type="checkbox"/>

(Filter: Erste beide Items nur falls Teilnehmender sich um einen Garten mit Kastanienbaum kümmert)

6. Wie sind Sie mit dem Befall der Kastanie in Ihrer Umgebung umgegangen? Was haben Sie dieses Jahr als Maßnahme gegen die Kastanienmotte unternommen?

	ja	nein
Ich habe Laub in meinem Garten gesammelt	<input type="checkbox"/>	<input type="checkbox"/>
Ich habe biologische/chemische Pflanzenschutzmittel angewendet	<input type="checkbox"/>	<input type="checkbox"/>
Ich habe an kollektiven Laubsammelaktionen teilgenommen	<input type="checkbox"/>	<input type="checkbox"/>
Ich habe Laubsammelaktionen initiiert	<input type="checkbox"/>	<input type="checkbox"/>
Ich habe mich genauer über die Kastanienmotte informiert	<input type="checkbox"/>	<input type="checkbox"/>
Ich habe andere Personen über die Kastanienmotte informiert	<input type="checkbox"/>	<input type="checkbox"/>
Ich habe die Kastanien in meinem Umfeld genauer auf eine verfrühte Braunfärbung beobachtet	<input type="checkbox"/>	<input type="checkbox"/>
Ich habe mich an das zuständige Amt, z.B. an das Gartenbauamt, gewandt	<input type="checkbox"/>	<input type="checkbox"/>
Ich habe andere Maßnahmen unternommen:	<input type="checkbox"/>	<input type="checkbox"/>

Anhand der nächsten Fragen möchten wir uns einen groben Überblick verschaffen, über das Interesse an biologischen Themen in Deutschland. Bitte kreuzen Sie jede Aussage an, die Sie als „**Richtig**“ einstufen. Es können **mehrere Antworten** pro Frage **richtig sein** und daher mehrere Antworten angekreuzt werden.

Nach Beantwortung erhalten Sie eine Auflösung.

7. Warum verfärben sich die Blätter von Laubbäumen im Herbst bunt?

Richtig

- | | |
|---|--------------------------|
| Das Chlorophyll, das das Blatt grün färbt, wird von den Blättern ins Bauminnere zur Speicherung abgezogen | <input type="checkbox"/> |
| Die Herbstsonne, die stärker strahlt, verbrennt die Blätter | <input type="checkbox"/> |
| Zu wenig Wasser im Spätsommer kann zum Verfärben der Blätter beitragen | <input type="checkbox"/> |
| Kalter Herbstregen enthält eine höhere Säurekonzentration, welche zur Rotfärbung führt | <input type="checkbox"/> |

8. Warum werden die Blätter von Laubbäumen im Herbst abgeworfen?

Richtig

- | | |
|--|--------------------------|
| Die kalte Zeit soll ohne Einfrieren und damit Absterben einzelner Äste überstanden werden | <input type="checkbox"/> |
| Wegen vermehrter Dunkelheit ist im Winter keine Photosynthese möglich | <input type="checkbox"/> |
| Es gibt keine Nährstoffzufuhr zu den Blättern | <input type="checkbox"/> |
| Die Bäume stellen ihre Blätter als Material zum Überwintern für Lebewesen (wie den Igel) zur Verfügung | <input type="checkbox"/> |

9. Was passiert mit den Insekten im Winter?

Richtig

- | | |
|--|--------------------------|
| Viele Insektenarten graben sich sehr tief in den Boden ein und verfallen in Winterstarre | <input type="checkbox"/> |
| Viele Insektenarten überwintern als Raupe, Puppe oder als Ei in Pflanzenteilen oder im Kokon | <input type="checkbox"/> |
| Insekten könnten ohne die warmen Häuser der Menschen als Winterquartier nicht überleben | <input type="checkbox"/> |
| Alle erwachsenen Insekten sterben | <input type="checkbox"/> |

10. Was wissen Sie über invasive Arten?

Richtig

- | | |
|---|--------------------------|
| In Deutschland sind als invasive Arten nur Säugetiere bekannt | <input type="checkbox"/> |
| Invasive Arten können einheimische Arten verdrängen | <input type="checkbox"/> |
| Invasive Arten sind eine Bereicherung für die Ökosysteme in Deutschland | <input type="checkbox"/> |
| Invasive Arten haben in ihrem neuen Lebensraum meist keine natürlichen Feinde | <input type="checkbox"/> |

Hier finden Sie nun die Auflösung:

7. Warum verfärben sich die Blätter von Laubbäumen im Herbst bunt?

Richtig

Das Chlorophyll, das das Blatt grün färbt, wird von den Blättern ins Bauminnere zur Speicherung abgezogen ✓

Die Herbstsonne, die stärker strahlt, verbrennt die Blätter

Zu wenig Wasser im Spätsommer kann zum Verfärben der Blätter beitragen ✓

Kalter Herbstregen enthält eine höhere Säurekonzentration, welche zur Rotfärbung führt

8. Warum werden die Blätter von Laubbäumen im Herbst abgeworfen?

Richtig

Die kalte Zeit soll ohne Einfrieren und damit Absterben einzelner Äste überstanden werden ✓

Wegen vermehrter Dunkelheit ist im Winter keine Photosynthese möglich

Es gibt keine Nährstoffzufuhr zu den Blättern ✓

Die Bäume stellen ihre Blätter als Material zum Überwintern für Lebewesen (wie den Igel) zur Verfügung

9. Was passiert mit den Insekten im Winter?

Richtig

Viele Insektenarten graben sich sehr tief in den Boden ein und verfallen in Winterstarre ✓

Viele Insektenarten überwintern als Raupe, Puppe oder als Ei in Pflanzenteilen oder im Kokon ✓

Insekten könnten ohne die warmen Häuser der Menschen als Winterquartier nicht überleben

Alle erwachsenen Insekten sterben

10. Was wissen Sie über invasive Arten?

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In Deutschland sind als invasive Arten nur Säugetiere bekannt

Invasive Arten können einheimische Arten verdrängen ✓

Invasive Arten sind eine Bereicherung für die Ökosysteme in Deutschland

Invasive Arten haben in ihrem neuen Lebensraum meist keine natürlichen Feinde ✓

Vielen Dank für Ihre Teilnahme!

Wir möchten uns ganz herzlich für Ihre Mithilfe bedanken. Bei Fragen zu dieser Studie wenden Sie sich bitte an Prof. Hans-Bernd Brosius von der LMU München unter:

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