Understanding connection with nature at an Amazonian deforestation frontier

Katarzyna Mikołajczak

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All my life through, the new sights of Nature made me rejoice like a child.

– *Marie Curie-Skłodowska*

Declaration

This thesis has not been submitted in support of an application for another degree at this or any other university. It is the result of my own work and includes nothing that is the outcome of work done in collaboration except where specifically indicated. Many of the ideas in this thesis were the product of discussions with my supervisors Luke Parry, Jos Barlow and Alexander Lees.

Abstract

Despite a widespread conviction that conservation's success depends on people genuinely caring about saving nature, there is very little scientific research examining how "caring for nature" influences conservation decision-making – particularly in poorer tropical countries. Instead, mainstream conservation tends to focus on economic motives to incentivise pro-conservation behaviour. To better understand the role of intrinsic motivations in nature protection in the tropics, this thesis draws upon the psychological concept of connection with nature (CWN), which describes people's self-identification with nature and emotional attachment for the natural world. This concept is applied to understand intrinsic motivation for conservation among non-indigenous colonist farmers living at the Transamazon Highway deforestation frontier in the Brazilian Amazon. The thesis tests the applicability of the CWN framework to the context of rural populations in the Global South and scrutinises conventional wisdoms regarding "caring for nature", including that poor people do not care about the natural environment, and that caring for nature is strongly linked to ecological knowledge.

First, a new tool for measuring affective CWN in rural areas is developed and validated. This measure is then applied together with an existing cognitive CWN scale to form the first assessment for CWN among farmers in the tropics. Next, the influence of CWN on the farmers' conservation attitudes is compared to that of other economic, socio-demographic, geographic and psychological factors. Contrary to widely-held assumptions, CWN is shown to be widespread and more important in shaping farmers' conservation attitudes than economic factors. Lastly, the relationship between caring for nature and ecological knowledge is tested. The results suggest that CWN is unconnected to ecological knowledge and associated with different predictors. Collectively, the results highlight the need for greater attention to intrinsic motivations for conservation and suggest CWN as a useful framework for understanding and improving people's relationship with nature.

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1 General introduction

1.1 Subjective motivations – a historical blind-spot in conservation science

Modern Western conservation science started out in the 1980s as conservation biology – a "crisis-oriented", "mission-driven" discipline to protect the world's biodiversity against mounting anthropogenic pressures, with problems and solutions framed by the established biological sciences and resource management disciplines such as forestry, fisheries, agronomy, and wildlife management (Soulé 1985; Meine et al. 2006). Most of contemporary conservation science research still continues to focus on biological issues, such as anthropogenic impacts on biodiversity or the ecological sustainability of bushmeat harvesting, and on the economic and regulatory approaches to govern the management of natural resources. Notably, from the 1990s, consistent with the wider trends in governance and policymaking, mainstream conservation became increasingly dominated by neoliberal thinking (Honig et al. 2015). Environmental economics developed into a near-hegemonic framework for "solving" trade-offs in the demands of people and nature protection, premised on the capitalist logics of subsuming ecosystems into markets as externalities.

However, social sciences and humanities have also began to increasingly weigh in on the question of appropriate governance of the world's biodiversity and "natural resources". Sustained criticisms from political ecologists and others challenge the conservation "industry" to think beyond, or at least consider the consequences of, the "capitalist conservation paradigm" (Brockington & Duffy 2011). Moreover, other disciplines such as social psychology have helped to popularise the understanding that "conservation is primarily not about biology, but about people and the choices they make" (e.g. Schultz 2011; Clayton et al. 2013) – a realization that has been described as an "epiphany" for natural scientist (Balmford & Cowling 2006). Today, there is a general acceptance in conservation circles of the "critical importance" of integrating social sciences into the global conservation agenda (Bennett et al. 2017). Yet, despite important progress being made, social science is still far from mainstream in conservation research and practice (Bennett et al. 2017). Even in the domain of human conservation behaviour, disciplinary views consistent with the neoliberal logic such – such as behavioural economics (McMahon 2015; Klein 2017) – continue to be privileged over other perspectives, such as considerations of moral foundations of pro-

environmental behaviour coming from social psychology (see e.g. Cinner 2018 for a prominent recent example).

Echoing others, this thesis identifies the unclear role of people's subjective motivations in conservation behaviour as an important blind-spot of conservation science (Zylstra et al. 2014; Abson et al. 2017; Zabala et al. 2017). On the one hand, there is nothing new in the idea that an enduring sense of a deep, personal bond with nature is the foundation for a personal environmental ethic capable of curtailing one's ecologically irresponsible behaviour and of fostering a caring relationship with the natural world. Similar thoughts are replete in environmentalist writings and are the mainstay of deep ecology and environmental education (Brennan & Lo 2016). Prominent conservation biologists also have come to identify progressive loss of nature experience from people's lives and the – presumably consequent – apathy towards environmental problems as one of the key issues underlying the conservation crisis, and have issued calls to 'reconnect' people to nature in order to restore a sense of care for the natural world (e.g. Pyle 2003; Miller 2005; Balmford & Cowling 2006; Ives et al. 2018). On the other hand, subjective motivations for nature protection, particularly intrinsic motivations such as caring about nature for nature's sake, continue to be to be ignored in mainstream conservation science. Despite insights from social psychology that people can be motivated to protect nature by various considerations including moral concerns (Clayton et al. 2013; Klöckner 2013), most conservation studies and many practitioners only seem to consider the economic, resource-related basis for motivation of conservation action or lack thereof (Edwards-Jones 2006; Zabala et al. 2017).

Compounding the problem is a persistent assumption that poor people simply don't care about environmental problems (Gray & Moseley 2005; Dunlap & York 2008). Indeed, this notion is implicit or explicit in publications coming from some of the most important global funders of international conservation and development work. For instance, Gray & Moseley (2005) cite the following excerpt from the World Bank's World Development Report (1992) on development and the environment: "Poverty is also a factor in accelerating environmental degradation, since the poor, with shorter time horizons… are unable and often unwilling to invest in natural resource management…". This culturally discriminatory idea is rooted in three influential trends of the twentieth century: Malthusian assumptions that poor working classes cannot afford to think

beyond their next meal (Gray & Moseley 2005), Maslow's hierarchy of needs and related social value theories which portrayed caring about nature as a distinctly higher-level need (e.g Inglehart 1997), and the cold logic of the Homo economicus – the idealised rational man who makes only calculated, self-interested decisions to maximise his own profits, and who until just recently ruled standard economic models of human behaviour (Aktipis & Kurzban 2004). Most of these ideas have become heavily criticised over time, yet the assumption that the 'the poor don't care about nature' became entrenched as a largely untested conventional wisdom, when instead it should be the subject of empirical enquiry (Dunlap & York 2008).

Another such conventional wisdom associated with "caring for nature", is the idea that caring for the natural world is predicated on knowing the natural world, often equated with having factual knowledge about natural history, biology and ecological sciences (e.g. Hammond & Herron 2012; White et al. 2018). Admittedly, this notion may have less grave consequences for the design of international conservation interventions by funders such as the World Bank than untested assumptions about poor societies not caring about nature protection. However, if inaccurate, this idea may nonetheless hamper any efforts that actually consider caring for nature to be important for conservation and that try to in still intrinsic concern for nature among children or the general public. For instance, Stern et al. (2014) have shown that environmental education programmes, whose overt aim is usually to increase awareness and caring about environmental problems and to influence behaviours, generally only measure increases in ecological knowledge as an indicator of programme effectiveness.

As a result of disciplinary biases giving more weight to economics than to psychology in conservation science, and of conventional wisdoms supplanting for factual knowledge about "caring for nature", empirical evidence in conservation says little about how our inner worlds may affect conservation outcomes. Hence, in many of the most biodiverse and threatened areas of the world, especially in poorer tropical countries, we simply do not know to what degree people care about protecting nature at all, who cares and who doesn't, and what are their motivations for feeling that way. Perhaps more importantly, we largely don't know how feelings of connection and care for nature shape decisions directly affecting threatened biodiversity (e.g. decisions around agricultural land-uses), nor how different conservation interventions may be

affecting these feelings and their environmental outcomes. This thesis takes it as its point of departure that, in the face of accelerating biodiversity loss despite some 40 years of concerted conservation efforts, such questions have become fundamental for conservation science to address.

1.2 Connection with nature as a basal component of psycho-social theoretical framework to understand intrinsic motivation to help nature

Despite exciting contributions to conservation debates from social scientists, the training received by most conservation scientists remains primarily biological. Consequently, many ventures into inter-disciplinary and multi-disciplinary research by conservationists often have rather loose theoretical underpinnings (St. John et al. 2014). Nonetheless, a number of established theoretical frameworks from psychology, anthropology, behavioural economics, and social marketing have started to take a strong hold in conservation science. This thesis builds primarily on the contributions from social psychology. Specifically, I focus on the concept of "connection with nature" (CWN). This construct holds much promise as an important foundation of intrinsic motivation for protecting nature, has documented positive links to pro-environmental behaviour (Geng et al. 2015), and is possibly malleable through repeated nature experiences (Schultz & Tabanico 2007; Bruni et al. 2008; Lumber et al. 2017). However, so far it has received little attention in conservation science (Restall & Conrad 2015; Ives et al. 2017).

Psychologically, CWN is the fundamental belief that we hold about our personal relationship with the natural world: whether we believe ourselves to be part of nature or separate from nature. Probably the most widely used theory of the effect of CWN on pro-environmental action is the model called Inclusion of Nature in Self (INS) (Schultz 2002, 2004), built in analogy to a model of interpersonal closeness (Aron et al. 1992). INS proposes that a sense of personal interconnectedness with nature is the result of a conscious or subconscious expansion of the self-concept to include nature or some of its elements, often prompted through nature experiences in nature. The stronger a person feels interconnected or "in one" with nature, the stronger she values it for its own sake, and the more likely she is to develop an intrinsic concern over the wellbeing of all living things (biospheric concern) (Figure 1.1.). By contrast, people with weaker

interconnectedness with nature are likely to develop concern over environmental problems only if they perceive them as harmful to other people (altruistic concern), or to self and close others (egoistic concern) (Schultz 2000; Snelgar 2006). Connection with nature is also related to positive affect[1] towards nature, including feelings such as love and care for other living beings, and awe with the beauty of the natural world (Perkins 2010).

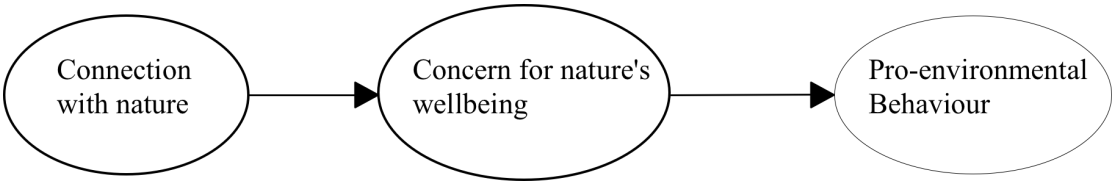

Figure 1.1. Model of the pathway from connection with nature to pro-environmental behaviour according to the theory of Inclusion of Nature in Self.

To my knowledge, thus far there has been little effort to integrate CWN with wider psycho-social frameworks of environmental behaviour motivation. The most common and well-established of such frameworks – the Theory of Planned Behaviour ("TPB", Ajzen 1991), the Norm-Activation Theory (Schwartz & Howard 1981), and its extended version the Value-Belief-Norm theory ("VBN", Stern 2000) – can be combined into unifying and empirically supported models of behaviour motivation (e.g. Klöckner 2013; Han 2015). The Figure 1.2 below shows a simplified version of a unifying model for the TPB and VBN, outlining the contributions of both theories and the distinction between proximal and more distal determinants of behaviour. The model shows that most of the proximal determinants of intention and behaviour comprise the elements specific to the TPB: attitudes (how favourably or unfavourably we evaluate the outcome of the behaviour), subjective norms (whether we believe important others would approve of us performing the behaviour), and perceived behavioural control (how confident we are in our ability to perform the behaviour). According to TPB, these constructs comprise a parsimonious set of motivations universally applicable to any deliberate decisions, which explains most of variation in intention – the strongest predictor of conscious action. The TPB is the theory that appears to currently dominate

[1] Affect can be defined as a broad category describing any of the internal experiences of the "feeling states" that we refer to as emotions, moods and sentiments. For elaboration on the distinctions between these different states by various authors see Ekman & Davidson (1994)

those conservation studies which apply psycho-social concepts to explain behaviour (e.g. St John et al. 2011; Mastrangelo et al. 2014; St. John, Freya A.V. et al. 2018). However, motivation to behave in an environmentally responsible manner can be said to contain also a prominent moral component, for which TPB does not account adequately (Klöckner 2013).

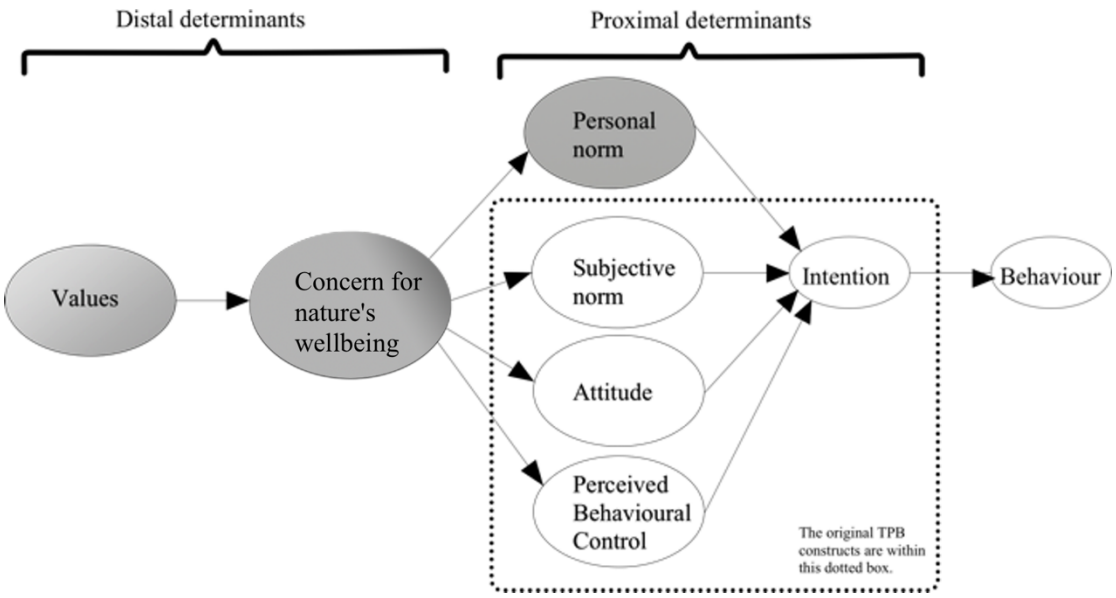

Figure 1.2. A simplified version of a model unifying the Theory of Planned Behaviour (TPB) and Value-Belief-Norm (VBN) theory.
Adapted from Klöckner (2013) and Han (2015). Original elements specific to VBN are in grey ovals and original components of TPB inside the dotted box. Distal and proximal determinants refer to determinants of behaviour. This framework has not yet been formally integrated with theories on CWN.

The moral pathway to environmental behaviour is accounted for primarily by components coming from the VBN theory. At the most fundamental, broad level of moral motivations for environmental behaviour lay values, described as trans-situational desirable goals, varying in importance, that serve as guiding principles in a person's life (Schwartz 1992, Schwartz et al. 2012). In other words, values represent the ideals a person finds worth striving for (Hitlin 2003). In the context of behavioural motivation, values are conceptualized as stable beliefs that permeate the entire motivational structure, affecting other, more situation-specific, beliefs, norms, and attitudes. For example, someone with strong intrinsic values, such as living in harmony with nature, is likely to develop a consistent ecological worldview and concern for nature's wellbeing, which in turn affect the more proximal determinants of behaviour, including both the TPB determinants and the personal moral norm – a "feeling of

personal obligation to act" linked to one's self expectation' (Stern 2000). Although acting primarily at a distal level and rarely showing strong correlations to any one behaviour, moral motivations also merit attention from conservation scientists. This is because, in contrast to the proximal determinants, which are behaviour- and context-specific, moral motivations can affect whole suits of behaviours recognised as relevant to one's values. In other words, someone with strong intrinsic motivation to protect nature is likely to consistently try to make environmentally responsible choices across very different behaviours, from food, through transport and energy, to land-use related decisions.

Where would CWN fit within this unified TPB-VBN framework? According to the INS theory, connection with nature could be classified as another distal component of moral motivation for environmental behaviour. Empirical evidence supports the notion that connection with nature acts at a deep level to promote pro-environmental action, as it's effect has been consistently shown to be mediated by environmental concern (Schultz 2000; Schultz et al. 2004; Gosling & Williams 2010) and social identities internalising concern for nature (e.g. Lokhorst et al. 2014). Some studies also suggest that CWN can in fact promote biospheric values, related to intrinsic concern for the wellbeing of all nature (Weinstein et al. 2009; Martin & Czellar 2017). Thus, CWN could be positioned on the presented model as an antecedent – or at least a modifier – of biospheric values. However, such framing is likely to meet with opposition from some psychologists working with values, because the VBN theory rests upon a conceptualisation of values consistent with the Theory of Basic Human Values (Schwartz 1992; Schwartz et al. 2012), where they represent the core, deepest level of motivation. According to this framing, since CWN is not a value, it must be located lower down in the hierarchy of motivational factors.

To reconcile empirical evidence on CWN with value-based theories of behavioural motivation, in this work I adopt a theoretical framework which views both values and connection with nature as the core elements of a personal identity or self-model (Figure 1.3). Such a conceptualisation has already been implicitly proposed for CWN by the Inclusion of Nature in Self theory (Schultz 2002; Schultz et al. 2004), and for values by an integrative theory of personal identity by Hitlin (2003). In the absence of more empirical evidence, I do not specify the exact theoretical relationship between CWN

and values beyond postulating that the two are distinct yet recursively linked to each other, and both act as the foundational elements of the moral pathway for environmental behaviour motivation. In this thesis, I focus on a relatively small part of the entire motivational framework, measuring CWN itself (Chapter 2) and the effect of values, CWN, and additional exogenous factors on pro-conservation attitudes (Chapter 3). In addition, I assess the relationship between CWN and exogenous factors postulated to affect it, including ecological knowledge, access to nature, contact with nature, and direct economic reliance on nature (Chapter 4).

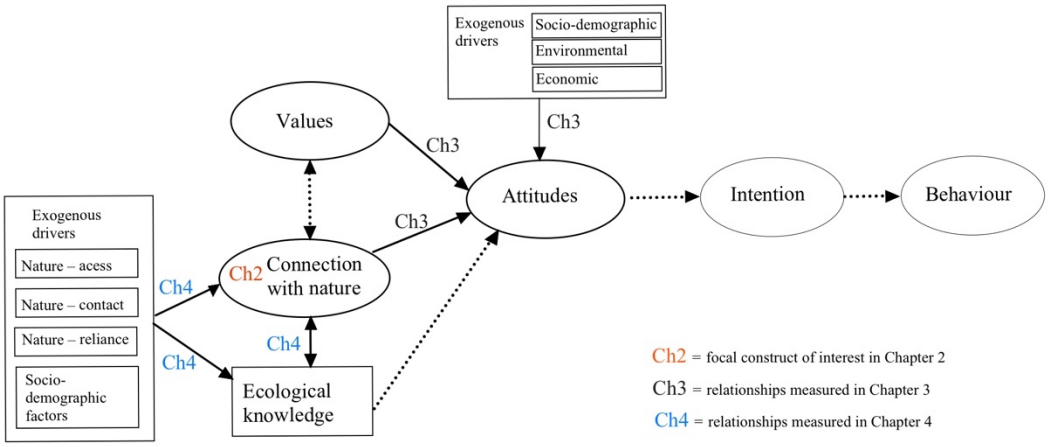

Figure 1.3. Thesis theoretical framework.
Ovals represent psycho-social factors, rectangles represent exogenous factors. Solid arrows represent relationships tested in this thesis. Dotted arrows represent relationships assumed but not directly tested in this thesis.

1.3 Human motivation has both cognitive and affective components

In this thesis I make a point of using both cognitive and affective measures of CWN. In a similar way to conservation science overlooking the importance of understanding human behaviour, psychological research has had the tendency to side-line research on affect (Manfredo 2008). Even though most elements of psycho-social theories of behavioural motivation – values, attitudes and indeed CWN – are theorised to contain both cognitive (thought) and affective (feelings, moods, emotions) components, most theoretical frameworks and empirical research tend to focus solely on cognitions. This again is a likely legacy of the twentieth century positivist resentment towards the "irrational" and the unquantifiable. In the first half of the twentieth century psychology, striving for recognition as a natural science and dominated by behaviourists interested

in objective accounts of behaviour (Howitt 2010), viewed affective states as difficult to account for theoretically and even harder to measure, all in all a hindrance to rational decision-making and thus hardly a worthy subject for scientific investigation (Manfredo 2008).

Those psychologists who did undertake to study affect struggled to find consistent physiological patterns associated with emotions and often believed that different emotional states, as we commonly understand them, don't really exist at all. Rather, they were thought to function as cognitive constructs used to label only two core differences in affect – pleasure and displeasure, or sometimes even simply a state of generic physiological arousal – in different social situations. One such early study gives an example: "Imagine a man walking alone down a dark alley, a figure with a gun suddenly appears. The perception-cognition 'figure with a gun' in some fashion initiates a state of physiological arousal; this state of arousal is interpreted in terms of knowledge of dark alleys and guns and the state of arousal is labelled 'fear' " (Schachter & Singer 1962, p.380).

However, the work of pioneers of "affective neuroscience" such as Jaak Panksepp, began to experimentally reveal the biological basis of all emotions. Panksepp identified seven prototypic, cross-species emotional states associated with primal subcortical systems – termed SEEKING, FEAR, RAGE, LUST, CARE, PANIC/GRIEF and PLAY – which we share with all other mammals (Panksepp 2005; Panksepp & Watt 2011). Consistent with this view, though currently lacking neuroscientific evidence, higher-order emotions, such as guilt, pride, or shame are thought to arise as blends of the primary emotions, modulated through the function of cortical system and social learning. This suggests that complex emotions indeed likely contain an element of cultural construal. However, cross-cultural studies provide evidence that even the cognitions that we associate with these more complex subjective feelings often possess attributes that are consistent across different cultures (Kline et al. 2008; Jankowiak et al. 2015). For example Asian, European and American adults – despite some differences – universally associated "being in love" with certain core cognitions such as the willingness to sacrifice for the beloved, making them happy and constantly thinking about the object of their love (Jankowiak et al. 2015)

Besides neuroscientific evidence for the existence of emotions as biological states, phenomenological studies also point to the critical importance of emotions to the way that we experience and relate to nature (e.g. Schroeder 2007). Therefore, I believe that researchers interested in using self-report scales to quantify the differences in people's relationships with nature – as I do in this thesis – should make a conscious effort to include not only the cognitive but also the affective component of CWN in their assessments. Even though the words that we commonly use to label our subjective states may be socially constructed and provide only imperfect guides to the fine-grain differences between some of the more complex emotions, they do appear anchored in biological reality and should not be shunned as a tool – currently our only tool – to access the rich emotional lives of other people.

1.4 Psychology of intrinsic care for nature in real conservation landscapes: the case of Transamazonian farmers

One of the novel contributions of this thesis is to apply the CWN lens to understand motivation for protection of nature in an important socio-ecological context hitherto neglected by environmental psychology research. Several studies demonstrate CWN's positive relationship with pro-environmental attitudes and behaviours, yet very few have considered CWN in the context of "real" conservation landscapes. With just a handful of exceptions (Wilhelm-Rechmann et al. 2014; Rosa et al. 2018), existing research on CWN as an antecedent of pro-environmental behaviour remains overwhelmingly constricted to high income countries in the Global North (Restall & Conrad 2015) and considerations of ecologically-responsible behaviours relevant mostly only to Western urbanites. This may be because, by and large, CWN research is conducted by psychologists, who lack a tradition of field research in the rural areas of greatest conservation interest (e.g. farm-forest landscape mosaics across the humid tropics) so characteristic of conservation biology. This is not to say that nothing is known about cognitive and affective relations with nature in other cultures. On the contrary, the inter-cultural diversity of human-nature relations form an important line of inquiry in disciplines such as anthropology and human geography (e.g. Descola 2007). However, to the best of my knowledge, such studies rarely focus explicitly on the specific questions concerning the importance of a personal bond with nature for motivating decisions related to conservation.

To begin to answer these questions, empirical work in this thesis (Chapters 2, 3, 4) is based on my fieldwork conducted over ca. eight months in 2015 and 2016 in a tropical rural region in the South-eastern Brazilian Amazon – the area around the Transamazon Highway. Amazon deforestation is an issue of global concern and there is a rich tradition of exploring its drivers and dynamics from the perspective of agricultural economics, environmental demography (population-environment studies) and political economy. There is abundant evidence for the influence of household-scale factors such as demography and wealth (Deadman et al. 2004; Pacheco 2009), and for macro-scale factors including agricultural markets, environmental enforcement, fiscal incentives, and land tenure legislation (Binswanger 1991; Arima et al. 2014; Nepstad et al. 2014). However, economic factors alone cannot fully account for deforestation trajectories and land use choices (Dalla-Nora et al. 2014). For example, the popularity of extensive cattle ranching as a livelihood strategy among smallholders, as well as it's persistence despite low returns, appears to be rooted in cultural preferences and the perception of cattle ownership as a status symbol (Hoelle 2011; Garrett et al. 2017). A central assumption of this thesis is that that farmers' individual preferences for livelihood strategies, management techniques and more subtle decisions that can affect nature, such as allowing or persecuting hunting and selective logging on their lands, are also influenced by the strength of their sense of connection with nature.

In this section I introduce the context in which the Transamazonian farmers live and forge their subjective relations with nature. The area surrounding the Transamazon Highway region is a prominent deforestation frontier and the site of one of the most emblematic Amazon colonization projects of the Brazil's former military government. The project was part of the larger 1960's and 1970's plans of the military government to integrate Amazon with the rest of the country. It had the triple aim of consolidating Brazil's geopolitical claim to its Amazonian territory ("integrar para não entregar" – "integrate to not surrender"), ease the growing tensions around access to land in the South and North-East of the country, and turning large areas of Amazonian rainforest into a productive bread-basket for Brazil (Moran 1981).

Apart from the gigantesque endeavour of constructing a ca. 3000 km road cutting through swaths of previously remote, old growth forest, the Transamazon Highway

colonization project involved settling migrant families on 100 ha plots arranged along smaller parallel side-roads running perpendicular to the highway (Moran 1981). The side-roads, called “travessões”, are distributed every 5 km and the plots are 2500 m deep, so that each 100 ha property faces a side road on the front end and shares the rear border with property from the neighbouring side-road. Once the colonist farmers started to clear the forest for cultivation this spatial arrangement resulted in the emergence of the ‘fish-bone’ pattern of deforestation visible on satellite images. As a conservation measure, fifty per cent of each plot was to be earmarked as forest reserve. Since it was of course easiest to proceed with deforestation from the front end of the property facing the access road, this measure was envisaged to result in 2.5 km wide forest corridors running along the backs of the properties, but deforestation restrictions have often been disregarded.

Beginning in 1972, the government settled around 6000 families (particularly landless farmers from the impoverished Northeast region) along the newly built highway, under the slogan to give "men without land a land without men" – despite the presence of indigenous and traditional peoples, the Amazon was portrayed as a vast empty wasteland (Menezes 2007). Settlers were promised free land, access to markets, education and health care, though few of these promises materialised. Many thousands more families migrated to the highway on their own, even after 1974 when the government withdrew most of its support for colonists’ smallholder agriculture and focused mainly on large-scale development instead (Moran 1981). This turn in policy resulted also in the designation of several much larger properties (‘glebas’, usually 500ha large). Some smaller 100 ha properties were also purchased and consolidated into larger landholdings – a process that still continues today.

To understand CWN among the Transamazonian farmers and its relationship with various factors examined in this thesis, I collected all the quantitative data in a single round of fieldwork. Thus, chapters 2-4 rely on the same sampling design, explained in detail in Chapter 2. Although far from an ethnographic study, visiting people in their homes during my fieldwork, conversing, often sharing meals and staying overnight before travelling on the next day, gave me a glimpse into their current every-day realities. In many ways, nature is a defining quality in the life of the Transamazonian farmers, through their essential connection to land from which they derive their

livelihoods. Environmental regulatory frameworks in Brazil, especially the Forest Code (Soares-Filho et al. 2014), impose limits on how they can use the land. Currently, the Forest Code specifies that 80% of each property in the legal Amazon should remain forested. However, certain exceptions apply, as properties that were deforested past 80% up to 2008 are required to restore forest cover only to 50% and not 80% (Nunes et al. 2016). Furthermore, reforestation obligations vary with property size in terms of "fiscal modules" – agrarian measurements used by the Brazilian government to represent the minimum area of an economically viable rural property for each municipality. Properties with less than four fiscal modules are only required to preserve the native vegetation present on the property as of July 2008. In the area studied in this thesis, this exception applies to smallholder farmers (with up to 100 ha of land) and part of the medium landholders (those with up to 280 or 300 ha, depending on municipality) (Godar et al. 2012; Landau et al. 2012). The rural lifestyle is also a source of identity, and family-based property management, if respecting on-property reserves, can gain the farmers legitimacy as environmental stewards in current discussions regarding sustainable development in the Amazon (Bratman 2011).

The main income sources in the Transamazon area are cocoa cultivation and cattle ranching (Figure 1.4. (a) and (b)). Most of the farmers are smallholders who also supplement their income with other agricultural activities and retain at least some subsistence element to these activities, often producing for own consumption at least one of the following: poultry, eggs, pork, fruit, dairy, beef, cassava, as well as some vegetables from small home gardens and, increasingly, fish farmed in artificial ponds. Much of the work is done by hand, as few farmers have access to agricultural machinery beyond chainsaws. Households closer to the highway and urban centres tend to have access to basic amenities, but many houses lack running water and houses along some of the more remote side roads still were not connected to the electricity grid at the time of the study. Furthermore, transport in the region is difficult as the main artery – the Transamazon Highway – remains for the large part unpaved. In the dry season (circa June to October) the road chokes on red dust, and when it rains vehicles get easily stuck in the mud (Figure 1.5), sometimes causing multi-kilometre long traffic jams.

Figure 1.4. Examples of primary livelihoods and the rural way of life in the Transamazon region.
(a) Farmer (to the right) standing next to his cocoa tree. (b) Farmer preparing freshly butchered meat for storage. (c) Morning milking of the herd. (d) Insides of a kitchen in a remote household. (d) Farmer wheeling cassava or "mandioca" tubers (Manihot esculenta) to his processing station. (e) Farmer tending her vegetable garden. Photo credit: Katarzyna Mikołajczak

Different livelihood strategies and forms of land management across the Transamazon Highway area produce very different landscapes, where anthropogenic activities and native forests intermingle to varying degrees (Figure 1.6). Around 65% of all farmers adhere to the legal obligation to preserve at least 50% of the forest on each property in the form of reserve legal (legal reserve) (Godar et al. 2012). However, despite legal restrictions, some farmers have opted to deforest most or even the entirety of their properties, creating profoundly transformed, intensively managed cattle pastures. Others allow for some tree cover remaining on the pastures and retain more forest. Deforested areas, if not maintained, over time overgrow with palms and bushes – becoming the so called "pasto sujo" or "dirty pasture". Land may also be allowed to reforest for a time as a strategy to recover some fertility. Farmers specialised in cocoa production often retain higher forest cover on their properties than those specialised in cattle ranching, partly because they are often grown in agro-forestry systems i.e. in the shade of larger native trees and partly because cocoa provides higher return per hectare, so less land is needed to generate sufficient income. One likely expression of different levels of the need to "commune with nature" is how much tree cover farmers retain in close proximity of their houses. Some people put their houses in the middle of clear pasture, and many, perhaps most farmers, like to clear vegetation in close vicinity to

their the house – a custom apparently present already in the early day of colonisation to protect the house from infestation by snakes or insects (Moran 1977). Others add fruit trees to create shade-giving orchards around house, and a small number of people like to keep their houses surrounded by native trees.

Figure 1.5. Difficulties with transport on the Transamazon Highway.
Passengers of an inter-city bus pushing the vehicle stuck in the mud over a hill on the Transamazon Highway. Photo credit: Katarzyna Mikołajczak

Short of deforesting, probably the largest single threat posed by agriculture to remnant Amazonian forests is fire (Aragão et al. 2018; Withey et al. 2018). Burning is the primary way in which uncapitalized farmers without machinery clear land of vegetation. It is relatively cheap, labour-saving and temporarily boosts soil fertility through inputs of Phosphorous and Nitrogen from burnt ash. However, the fertility of cleared areas drops significantly after a few years of cultivation. Moreover, the combination of climate change and deforestation has led to increasingly hot and seasonally-dry climate in the Amazon (Nobre et al. 2016), and a growing number of fires now escape beyond the area intended for clearing and spread across neighbouring properties (Aragão et al. 2018). In extreme years where droughts are exacerbated by El Nino events, fires can spread for tens or hundreds of kilometres (e.g. Withey et al. 2018 document a 1 million ha burn scar affecting a region that includes the Transamazon Highway in 2015-16).

Fire is also the preferred method used by those that intend to clear large areas for pasture, despite the legal restrictions.

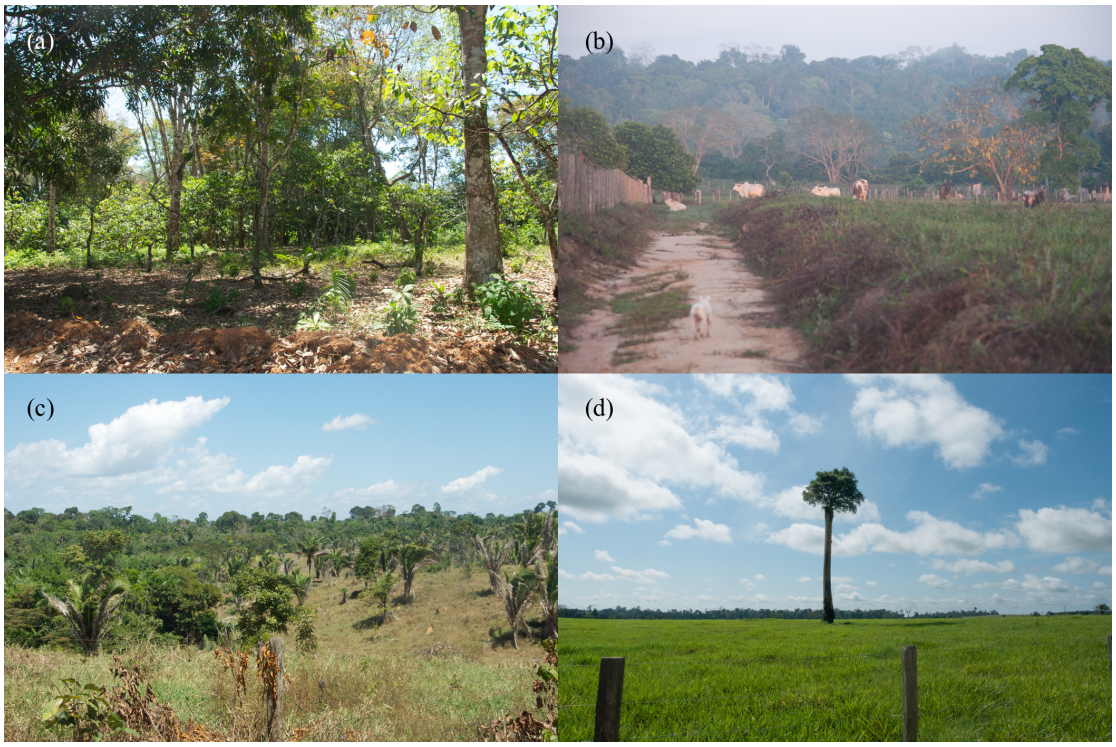

Figure 1.6. Examples of landscapes on Transamazonian properties.
All photos were taken from near the front end of each property – one bordering the access road (a) Young agro-forest with mixture of cocoa and native trees near the house, (b) cattle pasture with trees, bordering a forest remaining close to the property house , (c) "pasto sujerado" – area once completely deforested for pasture, now overgrowing with bacaba palm trees, (d) large "clean pasture" – near completely deforested and planted with exotic fodder grass species, with forest remaining only at the back end of the property. Photo credit: Katarzyna Mikołajczak

Other, perhaps more insidious threats to the integrity of Amazonian ecosystems are forest fragmentation, forest degradation through logging and defaunation through hunting (Barlow et al. 2016). However, activities such as logging and hunting may be the behavioural arenas where the influence of farmers' subjective relationships may be more readily apparent than in the proportion of the property that farmers decide to preserve. As we will see in Chapter 3, most farmers believe, sometimes with apparent regret, that at least some degree of deforestation is an inherent, necessary component to their agriculturalist way of life. However, no such strong and consistent beliefs seem to be associated with hunting or logging. Farmers take various stance on these activities. Except for a few enthusiasts, most of the farmers in this part of the Amazon rarely hunt and bushmeat, with the exception of paca (Cuniculus sp., a middle-sized rodent prised for its meat), is not a particularly popular source of protein. Indeed, bushmeat is

associated by many with being “remoso” (inflammatory). Those farmers who can afford meat from cultivated animals generally much prefer it. Still, many farmers permit hunting on their property but generally only for private consumption and not for commercial purposes. Other farmers, in contrast prohibit any forms of hunting or fishing, and remind others of this fact by displaying cautionary signs on property fences (Figure 1.7. (a)).

Likewise, while some farmers report selling individual trees to loggers, others feel it is their responsibility to completely safeguard their forest reserves and regularly patrol their land for any signs of illegal intrusion of loggers or hunters. The most vivid, if somewhat paradoxical, connections that farmers make with Amazonian nature are embodied in the relationships that some form with tame forest wildlife: most often large birds such as guans, parrots, and macaws, but sometimes also peccaries, monkeys or pacas (Figure 1.7. (c) and (d)). Some animals are allegedly “rescued” when young, e.g. from fallen nests during logging, though others doubtlessly are caught after the parents have been killed. Some people also keep small song birds in cages, but others condemn the practice as cruel.

Figure 1.7.Examples of anthropogenic threats and connections with nature in Transamazonia.
(a) Metal plate announces that hunting on this property is prohibited. (b) Forest burning to clear more space for pasture. (c) Farmer hand-feeding his tame "jacu" (White crested guan, Penelope pileata). (d) Farmer proudly presenting her free-flying friend, reportedly saved from a nest in a fallen tree (Scarlet macaw, Ara macao). Photo credit: Katarzyna Mikołajczak

1.5 Thesis aim, structure and objectives

1.5.1 Thesis aim

The purpose of this thesis is to advance the understanding of the importance of people's intrinsic motivations in the context of conservation in the human-modified tropical ecosystems. Specifically, I use theories and methods from social environmental psychology to study the role of connection with nature in forest and wildlife protection among non-indigenous farmers living along the Transamazon highway – a notorious deforestation frontier in the Brazilian Amazon. Furthermore, I use my empirical results describing the relationship between connection with nature, attitudes, and ecological knowledge to question entrenched views proclaiming that "poor people don't care about nature" and that caring for nature is borne out of knowing nature.

1.5.2 Thesis structure

In Chapter 2, I develop and validate a new method to measure emotional connection with nature adapted to the Amazonian context, and assess the levels of CWN among Transamazonian farmers, using this new affective measure and another independent scale measuring cognitive CWN.

Chapter 2 objectives:

- To develop and validate an affective CWN scale suitable for measurements within rural populations with low literacy levels, enabling the extension of quantitative inquiries into the role of CWN as a motivation for conservation beyond the Global North contexts.
- To measure and describe the levels of CWN among farmers living around the Transamazon Highway, taking into account both the cognitive and the affective component of CWN, thus providing the first assessment of CWN in the rural tropics.

In Chapter 3, I asses the relative importance of CWN among Transamazonian farmers on their beliefs and attitudes relevant to the conservation of local biodiversity, including general attitudes about the importance of nature protection and more specific attitudes related to tolerance of different animal species. I use the results to question the validity of the claim that poor people do not tend to feel care towards nature.

Chapter 3 objectives:

- To examine if the positive influence of CWN on pro-environmental attitudes and behaviours found in countries of the Global North extends to the relationship between the levels of CWN and the beliefs and attitudes towards conservation, including tolerance to wildlife on own land in the Global South.
- To assess the influence of CWN in shaping the conservation perspectives of tropical rural farmers, relative to other variables typically employed to explain conservation attitudes, including socio-demographic, environmental and economic factors.
- To assess if any detected influence of CWN on conservation attitudes can be distinguished from the influence of psychological value priorities.

In Chapter 4, based on a commonly held understanding that greater knowledge of nature breeds greater caring for the natural world, I test the hypothesis that a positive relationship exists between knowledge of nature and caring for nature. I provide a baseline description of the levels of ecological knowledge among the Transamazon farmers – as measured by the ability to identify common local bird species – and correlate them with levels of CWN (described in Chapter 2), used as measures of nature caring. I further explore the possibility of a link between ecological knowledge and CWN by examining if they share any potential geographic, socio-demographic, or experiential drivers.

Chapter 4 objectives:

- To measure and relate the levels of ecological knowledge and nature caring in the context of the rural tropics in the Global-South, in order to test the hypothesis of a positive link existing between them.
- To assess similarities and differences in the determinates of CWN and ecological knowledge, including socio-demographic, geographic and environmental factors.

In Chapter 5, I synthesise my findings, point out the limitations, and reflect on promising future directions for CWN research in conservation.

Chapter 6 presents references to the preceding chapters.

Chapter 7 contains the appendic

2 Assessing Connection with Nature Among Farmers at an Amazonian Deforestation Frontier

§ Assessing Connection with Nature Among Farmers at an Amazonian Deforestation Frontier

AUTHORS: Katarzyna Mikołajczak, Jos Barlow, Alexander C. Lees, P. Wesley Schultz, Claudia Pato, Luke Parry

2.1 ABSTRACT

Farmers' decisions are crucial for the preservation of world's biodiversity and there is a growing recognition that psychological factors are just as important as economic reasoning in shaping farmers environmental behaviour. Subjective connection with nature (CWN) may provide the basis for pro-conservation attitudes and behaviours, but so far has received only scant attention in literature on farmers' decision-making and has not yet been considered in the tropical regions. Here, we introduce a new scale of affective CWN tailored for use in the rural areas of the Global South, and provide the first assessment of cognitive and affective CWN in the tropics, among non-indigenous farmers living at a major Amazonian deforestation frontier in Brazil. We demonstrate high levels of CWN in the population, suggesting that it has the potential to positively influence the farmers' environmental views and decisions. We also highlight the importance of understanding exactly what nature people feel most connected to when responding to CWN measures.

KEY WORDS: connection with nature, emotional, affective, farmer behaviour, Amazon, conservation, tropics, scale development

2.2 INTRODUCTION

Recent contributions from environmental psychological research are challenging dominant economic paradigms in biodiversity conservation. Farmer behaviour, long the target of policy interventions using financial incentives to protect nature, is increasingly recognised as being shaped also by psycho-social factors, including values, identity, beliefs, attitudes, and norms (e.g. Meyfroidt, 2013). For instance, norms and attitudes were the main determinants of intent to engage in conservation by Australian cattle-

ranchers (Fielding et al. (2005), and landholders in the Argentinian dry Chaco (Mastrangelo et al. 2014). Understanding the psycho-social basis of land-use and wildlife-protection decisions among tropical landholders is particularly important (Mastrangelo et al. 2014), since the tropics contain almost 80% of the world's biodiversity and the majority of above-ground carbon (Avitabile et al. 2016; Barlow et al. 2018; GEOCARBON 2018).

This paper engages with connection with nature (CWN): a psychological construct describing the extent to which a person believes themselves to be part of nature (cognitive) (Schultz 2001, 2002), and feels emotionally connected to the natural world (affective) (Kals et al. 1999; Perkins 2010). CWN is promising because it may underlie the development of concern for nature and help explain attitudes and behaviours towards or against conservation goals. According to the Inclusion Model (Schultz 2002), CWN develops when meaningful experiences of nature provoke a subconscious expansion of the self-concept to include natural elements, which become valued, cared for objects. A perceived threat to valued elements in nature may provoke concern, prompting pro-conservation attitudes and response behaviours. Indeed, there is growing evidence from countries in the Global North of a positive relationship between CWN and pro-environmental behaviours, such as green purchasing decisions, signing petitions, or donating towards environmental causes (e.g. Tam 2013; Nisbet et al. 2008; Mayer & Frantz 2004; Perkins 2010). However, empirical research linking CWN with conservation outcomes is in its infancy (Ives et al. 2017), especially in rural areas in the Global South.

Several studies have examined the relationship between CWN and landholders' engagement with conservation. In Australia, farmers with high CWN appeared to do more than their peers to conserve native vegetation (Gosling & Williams 2010), and Dutch farmers with relatively high CWN had greater stated-intentions to conserve nature on their land (Lokhorst et al. 2014). These effects were mediated by environmental concern and self-identification as a conservationist, respectively. Using qualitative interviews and grounded theory, Bogdon (2016) found it common for Canadian landholders to develop a strong affective relationship with nature, which often led them to prioritise conservation-friendly land-uses (Bogdon 2016). However, it remains unclear if CWN may also underpin pro-conservation attitudes and behaviours

by farmers in the Global South, whose life experience can be very different to those of their counterparts in more affluent countries (Restall & Conrad 2015).When conducting research in these contexts it is really important that scales are short, simple, concrete, unambiguous and relatable (Camfield & Ruta 2007). Hence, even seemingly parsimonious scales often need to be adapted before use in different cultural contexts.

Cognitive CWN can be measured relatively easily with a simple, single-item graphical measure called Inclusion of Nature in Self (Schultz 2002). Measuring affective CWN is more problematic, because most of the dozen measures of affective and multi-dimensional measures of CWN include long abstract statements, which are likely to be challenging for rural respondents who may be unaccustomed to such a way of talking. Example statements are: "When I think of my life, I imagine myself to be part of a larger cyclical process of living" (Mayer & Frantz 2004), and "When I spend time in unspoilt nature I feel that my day-to-day worries seem to dwindle away in the face of the wonder of nature" (Perkins 2010). Some scales, such as Environmental Identity (Clayton 2003) and Nature Relatedness (Nisbet et al. 2009) conflate CWN with other constructs (e.g. environmental worldview and concern) (Brügger et al. 2011). Hence, these scales are unsuitable for assessing CWN's unique contribution to environmental concern and other pro-environmental attitudes. Other measures are urban-biased and not relatable for rural inhabitants, e.g. "My ideal vacation spot would be a remote, wilderness area." (Nisbet et al. 2009). These limitations mean that existing measures of affective CWN are unlikely to work well with rural people in the Global South, thus preventing its measurement in sites where psycho-social insights could be most relevant, i.e. sites of rapid and ongoing socio-environmental change.

Our study addresses the need for a method of assessing CWN in the rural tropics by modifying the Love and Care for Nature scale (LCN, Perkins 2010). LCN is a unidimensional measure of affective CWN, focusing on positive affect towards nature, and ranks highly among CWN measures in terms of correlations with pro-environmental attitudes and behaviours (Perkins 2010; Tam 2013). Through a qualitative appraisal of the scale, we believe it unconflated with other constructs. By making the LCN scale shorter, less abstract and more relatable to rural inhabitants, we created the Love and Care for Nature-Rural (LCNR) scale. We tested LCNR's psychometric properties in a case study of farmers inhabiting a deforestation frontier in

the Brazilian Amazon. We validated the affective LCNR scale against the cognitive Inclusion of Nature in Self scale (Schultz 2002), providing the first assessment of CWN in the tropics. We discuss the results in relation to previous CWN assessments from the Global North. We also examine participant's qualitative comments in response to CWN scales and draw attention to the unaddressed problems of individual-level variation in the understanding of meaning of "nature", and preference for some elements of nature over others. Finally, we consider the generalizability of the LCNR scale to other socio-environmental contexts and outline research priorities.

2.3 METHODS

2.3.1 Study region

The study was conducted between July and October 2016, within three municipalities in Pará State, Eastern Brazilian Amazonia (Figure 2.1.). The study area lies along a ca. 200 km section of the Transamazon Highway, an East-West road connecting large parts of previously remote Amazonia to the rest of Brazil's road network. The studied municipalities have been the site of one of the largest Amazonian colonisation projects of the military government in Brazil in the 1970s (Appendix 1 – Chapter 2 Supplemental methods). Each municipality is served by its own town, whereas the main sub-regional urban centre is Altamira (urban population ca. 77,200, IBGE 2010). As a deforestation frontier, the Transamazon provides an interesting context for studying CWN and conservation. Despite strict regulations on deforestation, ca. 8,265 km2 of forest has been lost since 1988 in the three municipalities in this study (INPE 2018). Stabilizing the farm-forest frontier and negotiating restoration where properties fall below legal forest cover thresholds both require an understanding of the determinants of environmental behaviours that influence forest cover (e.g. Caldas et al. 2007; Walker 2003) or changes in the abundance of animal species.

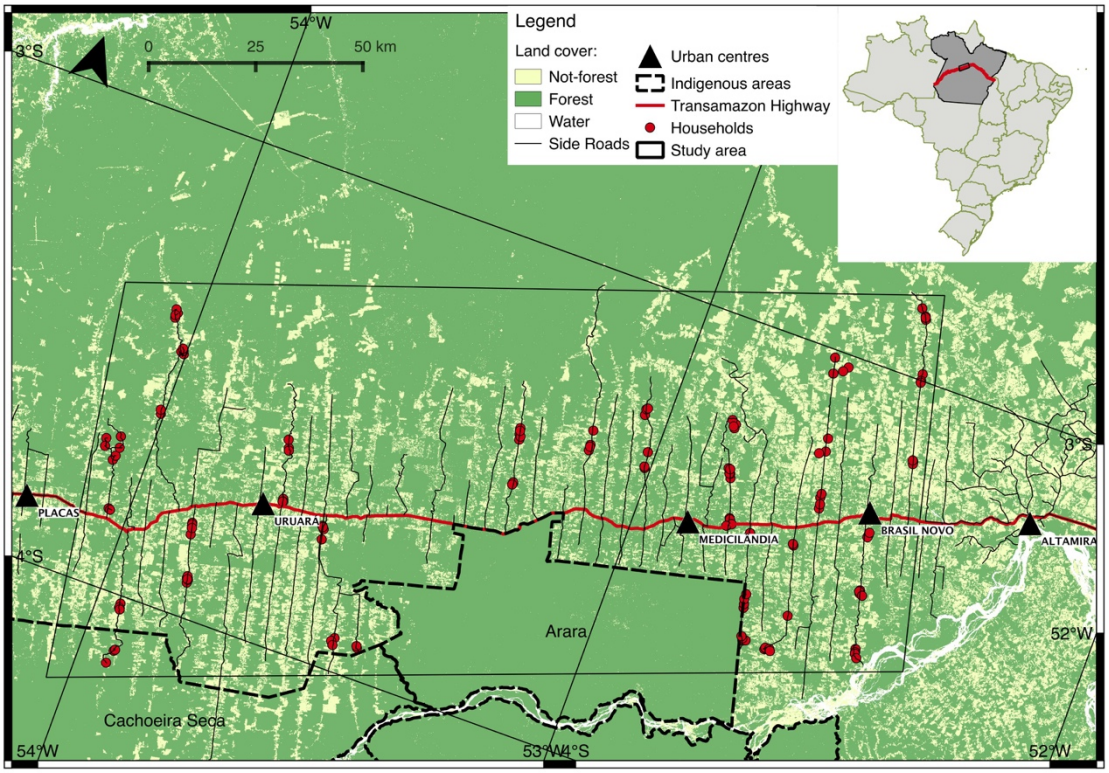

Figure 2.1. Map of the study region.
The bounding box of the study area covers ca. 17,838 km2.

2.3.2 The Transamazon farmers

Based on the limited ethnographic data available, first-generation colonists of the Transamazon are a diverse group whose self-identities are often tied to their place of origin (Lombardi do Nascimento 2009). Reportedly, a small proportion of early settlers were caboclos (traditional people of mixed indigenous and European ancestry) already resident in Amazonia (Moran 1981). Most, however, migrated from Southern and North-eastern Brazil, which are racially and culturally diverse, but characterised by centuries of Portuguese colonisation and large influxes of European immigration. Thus, many of the outer-state colonists descended from recent European immigrants and brought with them cultures strongly influenced by Western thinking. Accordingly, religion around the Transamazon is dominated by various forms of Christianity (Lopes 2012). In Western Christian thought, humans are perceived as essentially different from nature (Castree 2001). Seluchinesk (2008) found this view was common among farmers in Mato Grosso in south-western Amazonia and we assume that it is likely to dominate beliefs of Transamazonian colonists, too.

Western heritage, combined with the modern productivist paradigm dominating at the time, surely influenced the way Transamazonian settlers related to their land. Moran (1977) argued that early colonists did not appreciate their land for the natural resources offered by the forest (edible plants, game, fisheries) but rather saw its value in the agricultural potential for cattle, conventional crops and horticulture. Today, both first- and second-generation colonist farmers still see their primary function as agricultural production and identify themselves as rural workers and producers (as opposed to forest extractivists) (Sousa de Meneses, 2010). Although there is some evidence of affective relationships with the forest among Transamazonian farmers, conservation is not commonly part of their self-identity and environmental ethic is apparently not uniformly adopted (Lombardi do Nascimento 2009; Bratman 2011).

Using a typology by Godar et al. (2012), contemporary Transamazonian farmers can be distinguished based on socio-economic characteristic and landholding size into smallholders (55% of landholdings), owning <100ha; medium landholders (41%; 100-600ha); and large landholders (4%; >600ha). Smallholders tend to engage in diversified family agriculture, often a mixture of crops, cattle and sometimes cocoa, depending on soil fertility. The medium landholders generally practice family-managed extensive, low-capitalized cattle ranching.

2.3.3 Sampling design & participant recruitment

Properties were selected using a design intended to capture gradients in forest cover and distance from Altamira – sources of variation to be explored in separate publications. Land cover for sampling point selection was determined based on a composite raster of Landsat CDR OLI 2013-2015 images (30 m resolution), processed in QGIS (2016) using supervised classification into four classes: forest (primary and regrowing), water, non-forest, and cloud. First, we randomly selected fifteen rural Transamazon side-roads within Brasil Novo, Medicilândia, and Uruará. The selection was manually adjusted to ensure that no two sample-roads neighboured each other. Each selected side-road was divided into three equal segments (lengths varied depending on the length of the side-road) and a sampling point was randomly located within each segment. Locations were manually adjusted to ensure that sample points were ≥10-km apart, and the forest cover gradient (within 2-km radius of sampling points, a scale corresponding roughly to property sizes) was well represented. This meant relocating some sampling points

within side-roads with areas of very high (>85%) forest cover, from areas of low forest cover (usually points closest to the Highway), into areas of highest forest cover, and shifting the remaining points on the side-road if needed to maintain 10km distances between them. No prior knowledge of the local farmers characteristics was used in relocating sampling points. Proportion of forest cover varied from 0.20 to 0.89 for the final sampling points selection. All the above procedures were done in r using packages raster and sp (Pebesma & Bivand 2005; Bivand et al. 2013; Hijamns 2018) .

Forty-five sampling points were located, six of which we abandoned because they were inaccessible and/or uninhabited. We attempted to interview the owners of the closest four properties to each sampling point (Appendix 1 – Chapter 2 Supplemental methods). Questionnaires were completed through face-to-face interviews conducted in Portuguese, by female interviewers (KM, a white foreigner, and Brazilian research assistants, including local and outer-state). Besides measures of CWN, the questionnaire included questions relating to respondents' socio-demographic, economic, and psycho-social characteristics regarding attitudes and beliefs towards wildlife and forest conservation, explored elsewhere.

Our sampling protocol resulted in a sample consisting mostly of small (51 %) and medium landholders (46 %), with 3% large-scale farmers. Although some of the properties closest to a sampling point belonged to the latter group, their owners rarely live on them and were usually not available for an interview. Likewise, we were unable to locate any owners of properties managed as private selective-logging projects, which are generally uninhabited and mostly forested. Consequently, our sampling is likely representative of small and medium landholders living in the area, but not of absentee landlords and forested plots owners, who may have different psychological motivations. Also omitted, we presume, are land speculators and pioneer colonists that did not permanently settle on their original plots, and that may have moved to clear forest elsewhere or back to their home states (Fearnside 2001; López-Carr & Burgdorfer 2013).

2.3.4 Ethics

Before interviews, each participant was presented with an information sheet regarding free and informed consent, explaining participation guidelines, objectives of the study, ways of storing data and privacy protection, risks, benefits, and contact information for the study authors. Interviews were voluntary, and no form of compensation was offered. As many participants were illiterate, interviewers typically read the form aloud (unless the respondent preferred to read it), and further explained it to address any doubts or concerns, until they were convinced that respondents fully understood it. Research was approved by the Lancaster University Research Ethics Committee (RS2015/68).

2.3.5 Love and Care for Nature – Rural scale (LCNR)

As a first step in the development of a scale suitable for measuring emotional connection in rural areas in the Global South, we reviewed the wording of 12 published measures related to nature connection to identify the emotional to be represented. We distinguished LCN as the most comprehensive and parsimonious scale for this task, unconflated with cognitive connection or other constructs. Our modified scale was intended to capture the same sub-dimensions as the original LCN; feelings of love, care, awe, empathy, sense of beauty, and sense of wellbeing derived from spending time in nature (Perkins 2010).

To create a simpler and shorter version of the LCN scale, we first identified pairs of items that appeared to tap into the same emotional dimensions and eliminated the more abstract item from each pair. Next, we wrote different versions of the remaining items using simpler language. In doing so, we were sensitive to the abstract meaning of "nature" (Schroeder 2005). The Portuguese word "natureza" is an exact translation of the English word "nature", with a similar level of abstractness and ambiguity. To make statements less abstract and to focus respondents on wild as opposed to domestic nature, we replaced the word "nature" in most statements with more relatable and locally-appropriate "forest, river, or lake", which represent the least anthropogenically modified environments in Amazonia.

We also added two items (7 and 8, Table 2. 1), tailored to the Amazonian context, intended to capture empathy towards animals, and empathy towards the environment.

These items – hunting for food and periodical forest burning to boost soil fertility – are common and relatable experiences in this region, though regarded negatively when performed without necessity. Therefore, the qualifiers "unnecessary" suffering and "out of control" fires were employed to preserve a non-judgemental item formulation. Due to Brazil's highly unequal social structure we were sensitive to the risk that interviewers could be perceived as "power holders", particularly by participants belonging to marginalised social groups. e.g. women, illiterate, and black people (Mullings 1999). Therefore, aside from striving to establish trust and creating a comfortable, relaxed interview atmosphere, we included a negatively scored item in the LCNR scale to control for the acquiescence and social desirability bias. This item was modelled after a statement in the Connectedness to Nature Scale (Mayer & Frantz 2004, Table 1.: item 9).

Face-validity of the new statements (how suitable the items seem to measure the purported concept "at face value") was assessed by an independent expert reviewer. The original LCN items and the new statements were then translated to Portuguese and all (28 statements in total) were trialled in pilot questionnaires with ten farmers during a preliminary study (11/2015), which also comprised informal conversations with farmers and four focus groups: one with undergraduate forestry students in Altamira, one with an organic farming cooperative, and two with small "convenience" samples of farmers. Farmers responding to pilot questionnaires were asked to indicate their level of agreement with each statement, but also to offer qualitative comments on its clarity.

Based on the feedback from the preliminary study, we prioritised items with simple, unambiguous wording. We eliminated statements referring to concepts of "emotional connectedness", "emotional closeness", or "oneness" with nature, at they proved difficult to convey accurately. We excluded the spiritual sub-dimension, because we found that it was easily conflated with the extent of one's sense of spirituality in general, as opposed to the degree to which nature forms part of a person's spirituality. The remaining items were reviewed by another independent expert reviewer and revised to change items with extreme valence (e.g. 'feeling miserable' was changed to 'feeling sad', its final formulation in item 7, Table 2.1.). Our final scale was composed of nine items (see Table 2.1.), measured on a 5-point Likert-like scale, from 1 ("Completely disagree") to 5 ("Completely agree"). To better understand the meanings attributed to

those items we also recorded any qualitative comments from respondents in the main study.

Table 2.1."Love and Care for Nature – Rural" scale items.
Phrases in bold and italics = Portuguese version used in the present study. LCN = statements from Love and Care for Nature scale (Perkins 2010), CNS = statements from Connectedness to Nature scale (Mayer & Frantz 2004)

Item number	Statement	Construct	Corresponding statements in existing scales
1	I feel great love for nature. ***Eu sinto um grande amor pela natureza***	Love for nature	LCN: I feel a deep love for nature
2	When I am in nature, I feel connected to other animals and plants. ***Quando estou na natureza, eu me sinto ligado com outros animais e plantas.***	Sense of connection with other living beings	LCN: When I am close to nature, I feel a real sense of oneness with nature, LCN: I feel a personal sense of interconnectedness with the rest of nature, CNS: I often feel a sense of oneness with the natural world around me.)
3	If I am angry or upset, I feel better if I spend some time near a forest, river, or lake. ***Se estiver com raiva ou chateado, eu me sinto melhor passando tempo na mata, no rio ou no lago.***	Affinity for nature when being upset, sense of wellbeing derived from nature	LCN: When I spend time in unspoilt nature, I feel that my day-to-day worries seem to dwindle away in the face of the wonder of nature
4	Being close to nature brings me joy. ***Estar próximo da natureza me traz alegria.***	Joy from nature	LCN: I feel joy just being in nature
5	When I am close to a forest, river, or lake, I am often enchanted by their beauty. ***A beleza da mata ou do rio, frequentemente, me encantam quando estou perto deles.***	Enchantment from nature – beauty, awe	LCN: I often feel a sense of awe and wonder when I am in unspoilt nature
6	Taking care of the forest and animals that live there is important to me. ***Me importo em cuidar da mata e dos bichos que ela abriga.***	Sense of care for nature	LCN: Protecting the wellbeing of nature for its own sake is important to me
7	I feel sad when I see animals suffering unnecessarily. ***Eu me sinto triste vendo bichos sofrer sem necessidade.***	Empathy for animal suffering (Excluded from final scale)	Authors own
8	I feel sad when I see forest fires out of control. ***Eu me sinto triste quando vejo queimadas na floresta sem controle.***	Empathy for environmental damage (Excluded from final scale)	Authors own
9	What happens to the environment does not affect me much. ***O que acontece com o meio ambiente não me afeta muito.***	Detachment from environment (reversed)	CNS: My personal welfare is independent of the welfare of the natural world.

2.3.6 Assessing LCNR scale validity

A crucial component of scale validity is reliability, i.e. the degree to which scale scores are repeatable under the same circumstances, usually estimated in the form of internal consistency. This is the consistency of results across scale items, evaluated based on the covariance structure of the test (DeVellis 2016). The most popular statistic for this task is the Cronbach's alpha (α) (Sijtsma 2009), yet, Zinbarg et al. (2005) demonstrate that the hierarchical omega coefficient (ωh) performs much better. The ωh can be calculated with the use of a bi-factor model (Holzinger & Swineford 1937; Schmid & Leiman 1957). The bi-factor model is a form of factor analysis – a group of statistical methods used to describe a series of observed, correlated variables in terms of a potentially smaller number of underlying, unobserved latent variables, or "factors". A bi-factor model consist of a general factor, meaning the main factor responsible for the commonality between all measured scale items and representing individual differences in the scale's target construct (here: affective CWN), as well as two or more uncorrelated group factors (see Reise, Moore, & Haviland, 2010 for an excellent introduction into the bi-factor model and its use in psychometric analysis). These group factors represent additional commonalities not accounted for by the general factor, found between smaller subsets of items tapping similar aspects of the scale, with each scale item loading at most on one group factor.

The ωh represents the proportion of total variance in the model accounted for by the general factor. The bi-factor model can further be used to assess the unidimensionality of the scale – the extent to which all items measure only one construct – by calculating the Explained Common Variance (ECV), i.e. the per cent ratio of the general factor eigenvalue (variance explained by the general factor) to the sum of the eigenvalues of all factors. Few scales in reality are purely unidimensional; a key advantage of the bi-factor model is that it allows researchers to simultaneously estimate the generalizability of a scale to the target trait of interest, and test the extent to which scale scores reflect some secondary traits measured by the group factors (Reise et al. 2010).

Because data were ordinal, the factor analysis was based on polychoric as opposed to Pearson's correlation matrices (Gadermann et al. 2012). To calculate the ordinal ωh , ECV and the ordinal α for the LCNR scale, we used a bi-factor model with functions

omega and omegaSEM in the psych package (Revelle 2017a) in the R programming language (R Core Team 2018). To determine the optimal number of factors to extract we used techniques from the nfactors function.

Tam (2013) demonstrated strong convergence between differing measures of CWN, suggesting that despite conceptual differences, they all capture the same higher-order construct. Therefore, any new measure tapping the CWN construct should likewise converge with older CWN instruments. Assessing our modified version against the original LCN scale was impractical both due to presence of items unsuitable for our study context and due to the questionnaire length and additional time burden for participants. Instead, to evaluate the convergent validity of the LCNR scale, we measured its relationship with INS.

2.3.7 Inclusion of Nature in Self (INS)

The INS is a single-item graphic scale of the cognitive aspect of CWN (Schultz 2001, 2002). The scale is composed of seven numbered diagrams depicting progressively overlapping circles representing "self" and "nature". In the first diagram, the two circles are barely touching, representing a person believing herself completely separated from nature. In the last diagram, the circles overlap near-completely, representing the belief of a person who considers herself the same as nature. The scale was introduced as follows: "The two circles represent you and nature. Please indicate which of these drawings best represents your relationship with the natural environment. How connected are you with nature?". Because many respondents had little or no formal education or experience of diagrams, the introductory statement sometimes required further explanation by the interviewer. However, following explanation, respondents had little difficulty in using the scale and answering the question.

2.3.8 Respondents' characteristics

We interviewed 241 people (58% males) from 147 properties. Respondents' ages ranged from 18 to 75 (mean 47, SD 13). Respondents owned between 5 and 2,140 ha of land (median 100 ha), in one or several properties. The respondents grew up in the North region of Brazil (n=107); the Northeast (73); Southeast (28); South (25) and Central-west (9) (SI).

2.4 RESULTS

2.4.1 LCNR – Internal consistency and convergent validity

We first assessed the reliability of each item using descriptive statistics. All exhibited strong negative skew, i.e. tendency for extreme-high responses (see Figure 2.2.). However, items 7 (empathy towards animal suffering) and 8 (empathy towards environmental damage) had extremely high means and kurtosis, and low standard deviations, indicating low discriminant value (
Table S. 7.1.). Hence, these items were eliminated from further analysis.

Alternative methods for estimating the optimal number of factors to extract from the data provided different solutions (which is not uncommon, Revelle, 2017). Therefore, a series of bi-factor models with one general factor, and zero, two (with equal factor loadings constraint), three or four group factors were examined. The only model with acceptable fit (n = 241, Chi-Square = 3.28, p<0.21) included a general factor and three sub-factors. Based on this model, the output from the omega function was $\alpha = 0.88$, ω h = 0.80, and ECV= 73%. Based on the bi-factor analysis, item 1 loaded only on the general factor, items 4 and 5 loaded on one group factor, item 9 loaded on a group factor of its own, and items 2,3 and 5 – the most variable items in the set – loaded together on the third group factor (Table 2.2). However, with no a priori hypothesis and limited sample size, we did not attempt to interpret the group factors.

Table 2.2. Factor loadings and factor eigenvalues of the Love and Care for Nature Rural scale items.
Schmid-Leiman loadings greater than 0.2 are presented. g = general factor, F1* = first group factor, F2 = second group factor, F3* = third group factor

Item	g	F1*	F2*	F3*
1.Love	0.64			
2.Connection	0.67		0.45	
3.Wellbeing	0.53		0.34	
4.Joy	0.76	0.26		
5.Enchantment	0.82	0.34		
6.Caring	0.61		0.36	
9.Detachment	0.71			0.7
Eigenvalue	3.26	0.23	0.47	0.55

Both the ordinal α and ωh were above the 0.7 threshold, suggesting good scale reliability (Streiner & Streiner 2016). The value of ωh indicates that the general factor

(interpreted as "emotional connection with nature") explains 80% of the variance in scale scores. In turn, the ECV shows that 72% of the variance explained by the model is attributable to this general factor, indicating that the scale is largely unidimensional. The Spearman correlation coefficient between the LCNR and INS measures was 0.46 ($p < 0.001$), indicating a moderately strong relationship between the two scales (Figure 2.3).

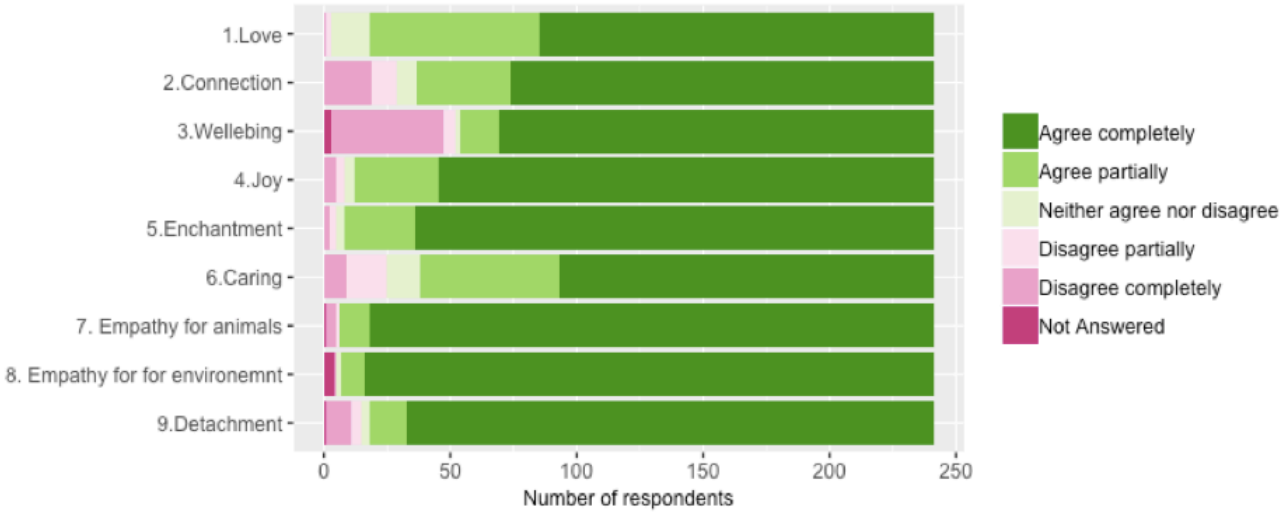

Figure 2.2. Response category distribution for each item of the "Love and Care for Nature – Rural" scale

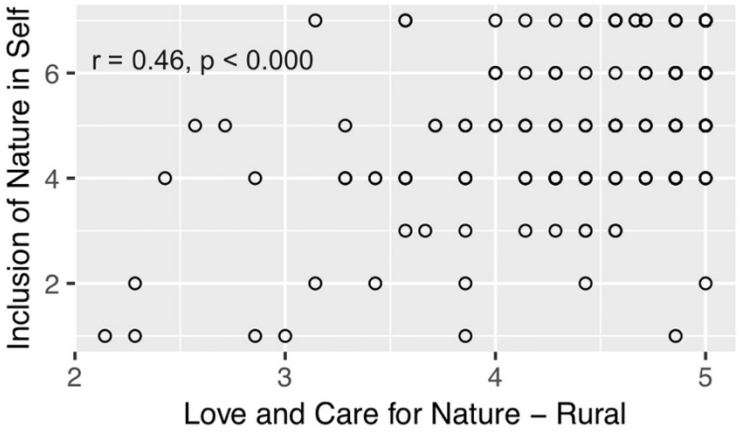

Figure 2.3. Spearman correlation between scores on the "Love and Care for Nature –Rural" and the "Inclusion of Nature in Self" scales.

2.4.2 Levels of CWN

On average, respondents scored highly on the INS scale (mean = 5.15 out of 7, SD = 1.48), and very highly on the LCNR scale (mean= 4.59 out of 5, SD = 0.50) (Figure 2.4).

Figure 2.4. Connection with nature measures score distribution.
Upper panel: "Love and Care for Nature – Rural" scale, lower panel: "Inclusion of Nature in Self" scale.

2.5 DISCUSSION

This paper presents the first appraisal of connection with nature (CWN) in the rural tropics, using a modified affective scale and a graphical cognitive scale applied to non-traditional Amazonian farmers. The Transamazon Highway, a notorious deforestation frontier, offers an ideal case-study for exploring the impacts of CWN and caring for nature on land management in areas of high ecological value. Transamazon colonists have been hailed sequentially as pioneering heroes, then environmental villains and more recently, conservation heroes (Campos & Nepstad 2006; Bratman 2011). However, despite dozens of studies examining drivers of regional deforestation, subjective attachments to nature and environmental subjectivities among farmers have been relatively neglected. Robust psychological tools can offer a way to systematically

appraise the relationship between people's attachment to nature and level of engagement in conservation (Restall & Conrad 2015). The method employed here enabled both a quantitative assessment of the levels of CWN in the study population and, through qualitative comments, generated a more nuanced view of the way in which the farmers construe their relationship with nature. Our main finding was that the modified Love and Care for Nature-Rural scale (LCNR) can be a valid and suitable method for assessing affective CWN in rural contexts in the Global South. Also, important, we found that farmers in the Transamazon area demonstrate comparatively high levels of CWN, both in the cognitive and affective dimension. However, qualitative data points to the importance of understanding exactly what nature people feel most connected to.

2.5.1 Validity of the LCNR scale

Our findings show that most LCNR scale variance is due to the common factor of CWN, indicating good internal-consistency reliability. The relationship we found between Inclusion of Nature in Self (INS) and LCNR was moderately strong ($r = 0.46$), indicating, as expected, that LCNR and INS are related, yet distinct constructs. This result is congruent with the range of previously reported correlations between INS and other Likert-like scales related to CWN ($r = 0.40$ to 0.86, median $= 0.63$, Tam 2013), including the correlation between the original LCN and INS among Australian tourists ($r=0.57$, Perkins 2010), providing support for convergent validity of the LCNR scale. Convergent validity can be further assessed using judgmental criteria to qualitatively compare scale content (Wieland et al. 2017). Because the items in the LCNR scale were modelled after statements in existing CWN scales (Love and Care for Nature, Perkins, 2010; and Connectedness to Nature, Mayer & Frantz, 2004), the statements we used are simplified yet coherent with the scales evaluated by Tam (2013). Together, the correlation between the INS and LCNR scales, as well as content similarity between LCNR and existing measures of CWN, suggest that our modified scale captures the same CWN construct as existing measures, albeit using simpler language (cf. Table 2.1).

A strong tendency for the extreme-high responses, especially on the LCNR scale, may raise concerns over their truthfulness. Several studies demonstrated that social desirability bias usually has only weak influence on answers to environment-related

surveys (Milfont 2009), however, in Amazonia the environment can be a sensitive topic due to legal restrictions on hunting and deforestation. Faced with strangers asking "environmentalist" questions, respondents may attempt to align their answers with the discourse of the socio-ecological environmental ethic, which legitimises family-based agriculture as a form of ecological stewardship, even if farmers have not internalised this ethic (Bratman 2011). Nevertheless, we remain confident in the honesty of the responses, primarily because participants' answers to CWN items were highly emphatic. Many comments illustrated people's sense of connectedness with nature, compassion towards it, appreciation for its restorative qualities and a sense of awe and joy when spending time in nature, whilst people declaring low connection provided counter-examples (see Table 2.3 for some examples and Table S. 7.2. for a full list of exemplar statements). Furthermore, respondents often freely offered far more sensitive information, admitting to cases where they disagreed with the environmental law and disclosing unsolicited examples of breaking the rules, e.g. killing a jaguar or clearing more forest than allowed (potentially illegal activities are not reported here). Nonetheless, the clumping of the majority of responses between the two extreme-high values (4 and 5) suggests that the scale may have been too coarse to reveal the full variability at this end of the scale.

Table 2.3. Exemplar comments to the LCNR scale illustrating respondents' connection and disconnection with nature.

	Connection	(relative) Disconnection
Sense of nature connectedness	"My focus is nature, planting. It's nature that we come from, and nature where we go back to, it's a part of us" "I am a daughter of nature."	"I like nature for recreation, but don't feel a connection" "I do not feel love for nature, I only use it to sustain myself."
Compassions towards nature	"An animal has got a life same way we do, even a plant breathes. In our forest we won't allow anyone to disturb the animals, no way!" "There is nothing more important than nature to me, I love it. I even had a quarrel with a traveller on the road, because I complained to him for killing a tamandua with no need. I don't kill nature's animals, only possums and snakes inside the property, but I don't like it at all."	"The forest is for giving shade and animals are for hunting." "There's so much peccary here, if I could I'd kill them all."
Self-restoration in nature	"I used to have depression. I cured myself at the river." [In nature] "I even feel at peace" "I like to [go to nature] to disconnect from the world."	"I am very afraid of the forest, of snakes and animals." "[I don't go to nature to feel better], I like to be in the middle of people. I won't isolate myself."
Awe and emotions in nature	"Everything is joyful there [in the forest]!" "The smell of the flowers! The green of the forest is life!"	

2.5.2 CWN on the Transamazon Highway

Most respondents scored between 4 and 7 on the cognitive INS scale and between 4 and 5 on the affective LCNR scale, hence our results indicate a moderate to high overall CWN among colonist farmers in eastern Amazonia. Due to non-equivalence, the LCNR scores are not directly comparable to results from previous studies, but the INS scores we recorded are higher than those reported elsewhere. For example, the average INS scores of Hong Kong students, a diverse United States sample, and Australian tourists ranged from 4.0 to 4.5 (Tam 2013, Perkins 2010), compared to 5.2 in our study. This is unsurprising because previous research assessed mostly urban populations whereas our respondents live in close proximity to natural areas and some rely directly on wildlife

for part of their food needs. Transamazon farmers may likely have more opportunities than urban citizens for interactions with nature, which are thought to promote CWN (Hinds & Sparks 2008). Likewise, a prolonged relationship with a natural place, such as on a farm, may encourage a greater sense of CWN (Bogdon 2016). Nevertheless, continued deforestation in the study region (INPE 2018) demonstrates that high average CWN does not translate into general protection of natural areas. One explanation is that the psychological CWN-behavioural mechanism proposed by Schultz (2002) functions differently in our study context, and CWN fails to activate cognitions consistent with environmental ethic. Alternatively, CWN activates pro-conservation cognitions, but conservation behaviour may be prevented by real or perceived barriers, e.g. lack of viable alternative livelihoods (Meijer et al. 2016), or failure to perceive one's actions as environmentally destructive (Kahn Jr 2003). While our data cannot support or discriminate between these possibilities, it highlights the need for further research.

2.5.3 Connecting to what?

High scores on the INS and LCNR scales suggest that farmers around the Transamazon Highway generally have strong connections to their natural environment. However, qualitative comments on the LCNR revealed heterogeneous conceptualizations of nature and varying strength of connections to different aspects of nature. For example, in response to "When I am in nature, I feel connected to other animals and plants", some people indicated that they felt connected with plants, but not animals, or vice versa. Others reported feeling a connection with all animals except snakes, consistent with (Öhman & Mineka 2003). Likewise, in response to "If I am angry or upset, I like to spend some time near a forest, river, or lake" (item 3), many interviewees expressed preference for a particular type of environment: forest, rivers, lakes, and sometimes agroforests or crop-fields. Yet, most of these respondents also scored highly for the INS and LCNR.

Apparently, farmers may connect to and self-identify with nature at large, yet have varied (and sometimes negative) levels of affective connection to different natural elements (Sowards 2006; Verges & Duffy 2010). Indeed, CWN is sometimes conceptualised as the strength of personal identification with nature recognised as a community or a collective (Clayton 2003; Tam 2013). In a group, the strength of relationships with different group members can vary, and special treatment may be

extended to members with whom one identifies most (Wellman & Wortley 1990). Yet, helping behaviours are commonly extended to in-group members (e.g. Kunst, Thomsen, Sam, & Berry, 2015), thus strong identification with nature at large could potentially promote a more inclusive view of and concern for all nature, even for its commonly disliked or unvalued elements (Zylstra et al. 2014). Accordingly, strong CWN appears to promote appreciation of nature that is not tied to a specific place (Colléony et al. 2017), but future research should verify if strong CWN can help overcome the anthropomorphic bias in conservation favouring species that humans can mostly readily identify with (Balding & Williams 2016; Root-Bernstein et al. 2013).

Qualitative insights also imply varied interpretations of what constitutes nature. For instance, one female farmer (Age 26) in response to the LCNR item 3 commented that she liked to spend time in the: "cocoa [agroforest], with birds. You may be worrying about something, but when you enter the cocoa, the forest, you feel so happy that you forget all the problems in your life. I love my cocoa [agroforest]". In this case "cocoa" refers to an agroforestry system where cocoa plants grow amidst native trees, which maintain some canopy cover, providing shade. These systems are intermediate between open-plantations and intact native forest, and partially maintain primary forest biodiversity and provision of ecosystem services (Bhagwat et al. 2008) The woman appeared to use the words "cocoa" ("cacao") and "forest" ("floresta") interchangeably, and did not make a big distinction between primary and anthropogenic forests. Indeed, the strong affective CWN she expressed appears tightly linked to her cocoa agroforest. By contrast, the same scale item provoked a very different comment from a male farmer (age 67): "I love nature, I don't even allow it anymore to open forest [deforest] to plant more cocoa [on my property]". This suggests that he distinguishes between primary forest and agroforests, and associates nature more strongly with the former. Despite these different conceptualisations of "nature", both respondents scored 5/5 on the LCNR, (albeit on the INS scale the woman scored 5/7 and the man, 7/7), suggesting both feel strongly connected to "nature" at large.

These examples illustrate that the word "nature" in closed-format questions obfuscates the connections that people have with different elements of it, and what objects they consider to be part of "nature". Responding to such questions, people appear to focus most on their preferred parts of nature. Moreover, people may include the domesticated

and the anthropogenic to a lesser or greater extent in their idea of what nature is (Vining et al. 2008; Colléony et al. 2017). Discrepancies in individual interpretations of what constitutes "nature" or "forest" could be problematic for conservation research and practice (Buijs et al. 2009). People who feel highly attached to nature, yet whose concepts or ideals of nature differ, may strongly disagree over desirable conservation policies or management action, e.g. restrictions on hunting, restoration of historical ecosystems or eradication of invasive species (Schroeder 2005). Currently, CWN theory and measures do not address the plurality of people's concepts of nature (Ives et al. 2017), which may potentially weaken the capacity of CWN-informed analyses to predict specific conservation attitudes and behaviours.

2.5.4 Limitations and future use of the LCNR scale

Despite important insights produced by this study, our methodology had some limitations that researchers using LCNR in future research may wish to address. First of all, this study is based on a single dataset situated within a particular socio-environmental context and the validity of the scale should be replicated on independent data from different populations. Secondly, the clumping of responses around the extreme-high end of scale suggests that the 5-point Likert-like scaling we used, though relatively easy to explain to participants who may be unaccustomed to such measures, may have hidden a considerable amount of variability between participants. To help reveal additional variation in responses we therefore recommend that researchers try to use the LCNR with a 7- or 10-point scale instead. Thirdly, although, as discussed earlier, we remain confident that most of our respondents replied honestly to our questions, the potential contribution of social desirability bias to the responses remains uncertain. One way to explicitly account for it in future studies would be to use an independent measure, such as the Social Desirability Scale -17 (Stöber 2001), to correct responses to LCNR.

Furthermore, the clustering of the most variable statements in our study – 2.Connection, 3.Wellbeing, and 5.Caring– on a single group factor (Table 2.2) suggests that it could be possible to reduce the scale without a substantial loss of information. However, the current, 7-item form of the LCNR scale is statistically reliable, conceptually consistent, and representative of the various emotional aspects of CWN theorised in the literature.

The three items in question represent only a subset of those emotional aspects and it is possible that they only clustered together due to chance in this particular dataset. However, if future studies conducted on independent datasets demonstrated that the same statements are consistently most variable, cluster in one group-factor, have high internal consistency and correlate highly with the full scale, then it may be possible to generate a shorter version of the scale, which could be particularly useful for field studies.

Finally, it is also important to point out that, the formulation of the LCNR scale was guided by pre-existing measures from Western countries and, like most CWN scales, the LCNR is bound by linguistic structures that make a semantic distinction between (human) "society" and (non-human) "nature" (Schroeder 2005). As such, it is likely to work best in societies characterised by Western influences that make a similar distinction between society and nature but may not always prove adequate otherwise. A remaining frontier is to explore how the concepts of cognitive and affective CWN may apply in cultures, such as many Amerindian and Australian aboriginal peoples, that draw different divisions between humans and non-humans and where the word "nature" may find no direct translation at all (Descola 2007).

2.6 Conclusions

In this first assessment of CWN in the rural tropics, we validate the "Love and Care for Nature – Rural" scale of affective connection and provide evidence for high levels of cognitive and affective CWN among non-indigenous farmers in the Brazilian Amazon. We designed this modified scale to facilitate incorporation into conservation research design, including in relatively remote rural areas of high conservation importance in the Global South. These areas have been largely neglected by environmental psychology researchers. Many in the conservation community are voicing a concern that nature cannot be effectively protected if people do not inherently care about its wellbeing. Relatively high CWN uncovered in this study among the Transamazonian farmers suggest that CWN has the potential to play a role in promoting pro-conservation attitudes and behaviours. Our modified version of Perkins's (2010) scale will enable researchers to empirically examine the link between emotional CWN and the

effectiveness of conservation interventions. We expect it to translate and perform well in those cultures whose languages make a semantic distinction between “nature” and “culture”.

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3 Connection with nature and values shape the conservation attitudes of Amazonian farmers

§ Connection with nature and values shape the conservation attitudes of Amazonian farmers

AUTHORS: Katarzyna Mikołajczak, Jos Barlow, Alexander C. Lees, Micha Strack, Oriana Trindade de Almeida, Frazer Sinclair, Luke Parry

3.1 ABSTRACT

Conservation has traditionally relied primarily on the 'carrot and stick' approaches of legal restrictions and economic incentives to motivate the protection of nature, rooted in the conventional wisdom that the poor don't care for nature beyond its utilitarian value. Yet insights from social and behavioural sciences suggests that strengthening intrinsic motivations may not only promote pro-environmental behaviours, but it may be in fact crucial for the transition to more sustainable societies and halting biodiversity loss. Here we measured the connection with nature (CWN) – a psychological construct describing the sense of belonging and emotional attachment to nature – as a marker of intrinsic care for nature to test if it relates to conservation views of non-indigenous farmers living along the Transamazonian highway – a notorious deforestation frontier in the Brazilian Amazon. We used generalised linear models to evaluate the relative importance of CWN to pro-conservation attitudes, compared to other psychological, economic, and socio-demographic factors.

Our analysis demonstrates that pro-conservation views are widespread among non-indigenous Amazonian farmers and shaped primarily by psychological factors: affective CWN and individual values. This result suggests that nature protection may not only be an important concern for the rural poor in the tropics, but also that intrinsic motivations may play a significant role in stimulating this concern, directly contradicting long-held, market-based assumptions underlying environmental protection thinking and policy at major institutions such as the World Bank. We propose that CWN provides a useful framework to understand – and potentially promote – intrinsic motivations for conservation in the tropics, and recommend that conservation should give greater consideration to intrinsic motivations for nature protection.

KEY WORDS: connection with nature, attitudes, tropics, values, environmental concern

3.2 INTRODUCTION

Conservation approaches to reduce pressures on natural environments are dominated by legal restrictions on the use of 'natural resources' and economic interventions, e.g. payments for ecosystem services (PES). Economic interventions are predicated on the conventional wisdom that people, especially the poor, are too pre-occupied with their material needs to see nature beyond utilitarian terms (Dunlap & York 2008). However, economic approaches, though useful, may be insufficient alone to achieve the systemic changes required for sustainability (Abson et al. 2017). Mounting evidence from the social and behavioural sciences, especially environmental psychology, demonstrates that people possess heterogeneous motivations for acting pro-environmentally, of which monetary gain is but one (Steg et al. 2016). 'Reconnecting people to nature' to strengthen intrinsic motivations, most likely to sustain repeated engagement in pro-environmental behaviours, may be one of the 'deep system levers' necessary to transition towards a sustainable global economy and reverse biodiversity decline (Ives et al. 2018).

Here, we evaluate how connection with nature (CWN) influences pro-conservation attitudes, relative to more traditionally recognised drivers. CWN is defined as the extent to which a person believes themselves to be part of nature (cognitive CWN) and feels emotionally attached to it (affective CWN) (Schultz 2002; Perkins 2010). Systematic differences in attitudes and behaviours have long been attributed to values (e.g. Bardi & Schwartz 2003), meaning a small set of relatively stable, trans-situational "desirable goals", which serve to guide action and express human needs (Schwartz 1992; Gouveia et al. 2014) and which may underpin the entire human motivation structure. More recently, psychologists began to explore CWN as a foundation for differences in intrinsic motivations to behave pro-environmentally, such as attitudes towards conservation and a sense of personal obligation to act. Theoretically, meaningful experiences of nature are thought to expand a person's concept of self to include elements of nature (Schultz et al. 2004; Clayton et al. 2017). These elements become

valued objects, giving rise to a sense of care and concern about the wellbeing of nature, catalysing pro-environmental attitudes and, eventually, behaviours.

Despite evidence in support of CWN promoting pro-environmental attitudes and behaviours (e.g. Tam 2013; Geng et al. 2015), three critical research gaps remain in our understanding of the relationship between CWN and the endorsement of a conservation ethic. Firstly, it is unknown to what extent CWN may promote attitudinal support for conservation in poor, rural areas in the Global South. Some evidence from temperate zone studies in the Netherlands, Australia, and Canada suggests that farmers with high CWN are more likely to engage in nature conservation on their land than farmers with low CWN (Gosling & Williams 2010; Lokhorst et al. 2014; Bogdon 2016). However, no such studies are available from the Global South – not least from the tropics containing >75% of global biodiversity (Barlow et al. 2018). In particular, it is unclear if CWN encourages biodiversity conservation universally, or only for a selection of its more appealing and relatable elements (Chapter 1, this thesis ,Verges & Duffy 2010). Secondly, the relative effect of CWN on conservation attitudes has yet to be compared with other predictors typically postulated to explain conservation attitudes, including economic and socio-demographic factors (e.g. Roque De Pinho et al. 2014; Suryawanshi et al. 2014). Lastly, most CWN studies consider it in isolation from value priorities. Evidently CWN strongly relates to the biospheric part of the larger-than-self Universalism values (Weinstein et al. 2009; Martin & Czellar 2017), but otherwise little is known about their relative contributions to conservation attitudes.

We address these knowledge gaps by testing the relative importance of CWN in shaping conservation attitudes among non-indigenous farmers living along the Transamazon Highway – a notorious deforestation frontier in the Brazilian Amazon. Specifically, we ask, 1) Does the positive influence of CWN on pro-conservation attitudes in the Global North extend to the Global South, 2) Is CWN a better predictor of pro-conservation attitudes than traditional predictors, including economic, socio-demographic, and environmental factors, and 3) What is the relative contribution of CWN and values to pro-conservation attitudes? Our human-modified tropical forest landscape setting, where balancing rural livelihoods and conservation requirements is a constant challenge, offers an ideal context in which to explore the extent and limitations of CWN in promoting pro-conservation motivations and behaviours.

3.3 METHODS

The study area was located along the Transamazon Highway in the south-eastern Brazilian Amazon in the municipalities of Brasil Novo, Medicilândia, and Uruará in Pará state (Figure 3.1.). The region is dominated by low-capitalised, family-based agriculture; the vast majority of the inhabitants are non-indigenous and migrated there following government incentives for colonisation from 1972 onwards (Moran 1981). Forest loss, degradation, fragmentation and over-hunting are the main threat to regional biodiversity. CWN has already been shown to be prevalent among regional farmers (Chapter 2, this thesis), but widespread poverty and development paradigms centred on productivity (Moran 1977) are likely to favour economic factors in decision making and exemplify motivational conflicts and limits to CWN in promoting pro-conservation attitudes.

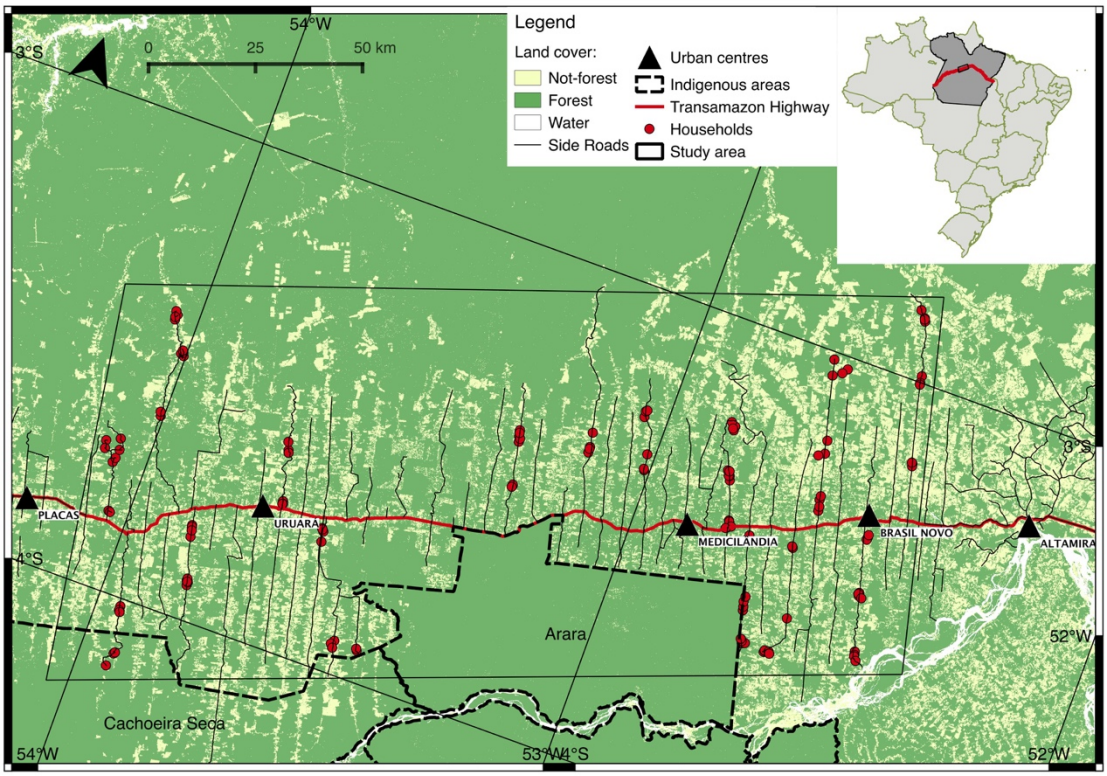

Figure 3.1. Study area map of the Transamazon region in the eastern Brazilian Amazon. The bounding box of the study area covers ca. 17,838 km2.

Sampling was stratified across 45 points along 15 of the "fishbone" side-roads running perpendicular to the highway and aimed to capture gradients in forest cover and distance

from the sub-regional urban centre Altamira (details Chapter 2). Due to inaccessibility or apparent lack of inhabitants, 6 points were abandoned. We aimed to interview the landowners and their spouses (or close family if involved on the farm) on the four properties located closest to each sampling point. If some refused (n=23) or were unavailable (n unrecorded), we moved to the next closest house if possible. To assess cognitive CWN, we used a graphical, single-item, 7-point scale "Inclusion of Nature in Self " (Schultz 2002). For affective CWN, we used a purposely adapted 5-point Likert scale (from 1= 'Completely disagree' to 5 = 'Completely agree) called 'Love and Care for Nature – Rural' (Chapter 2, this thesis), consisting of 7 items intended to capture feelings of love, care, awe, empathy and psychological wellbeing derived from nature.

To assess attitudes to conservation, we selected attitudes corresponding to two of the major conservation threats in the region: deforestation and defaunation through hunting. We included four general attitudes (Table 3.1.), expected to be indicative of a broadly understood conservation ethic. Responses to negatively formulated attitudes (1 and 4) were reverse-scored to align them directionally with the rest of positive, pro-conservation attitudes (Table 3.1). We also measured five time-, targeted-, and place-specific attitudes concerning desired changes in population status of five animal species of varying utility, appeal and conservation status. These are expected to reflect landowner tolerance of those species on their property. Lowland tapir (*Tapirus terrestris*), hyacinth macaw (*Anodorhynchus hyancinthinus*), and jaguar (*Panthera onca*) were considered relatable and rare, whilst pit vipers (genus Bothrops) and vine snakes (genus *Chironius*) were considered unrelatable and common. Tapir, hyacinth macaw, and vine snakes were considered as largely benign, while jaguar and vipers as potentially dangerous, since both can kill cattle and sometimes humans. The general pro-conservation attitudes were measured using 5-point Likert-like statements, from 'completely disagree' to 'completely agree'. Tolerance of each species was assessed by asking: *"In the next 10 years, how would you prefer the population of [animal] to change on your property?"*. The available answers ranged from 0 = "disappear completely", through 3 = 'no change', to '5 = increase a lot'. We also collected qualitative responses to open ended questions regarding respondents' perceptions of; (a) what would be an adequate level of forest cover on farming properties, (b) how much forest should be protected by law, (c) respondents' approval or disapproval for selective logging projects within the forest reserves on farming properties.

Table 3.1. General attitudes' statements.
Items 1 and 4 were phrased as negative, anti-conservation attitudes in the questionnaire. When responses to those items are reversed-scored, they can be presumed to express the opposite sentiments. Here both the original phrasing and the reverse-scored meaning are presented.

Item code	Statement
Att1. Development over nature (negative attitude)	The development of our region is much more important than protection of nature. **When reverse-scored**: expresses support for prioritising nature protection over development in the region.
Att2. Prevent extinctions	If some animal in the region starts to decrease, people should act to not let the animal disappear.
Att3. Protect forests	All the forests that still remain in the region should be protected.
Att4. Control wildlife (negative attitude)	Animals that are dangerous or damage crops should be controlled on private properties, even if they are rare. **When reverse scored:** Expresses objection to the need for controlling wild animals on private properties, even if they are danegours or

According to Schwartz' theory (1992), "basic human values" have a near-universal structure organised along two main axes: Universalism and Traditionalism. Though all values are important to most people, individuals ascribe varying priorities to different values. People high on Universalism spectrum tend to prioritise values such as equality, harmony with nature, and helping others. People low on Universalism tend more to value such attributes as power and achievement. Those with high Traditionalism tend to value conformity, security and tradition, whilst those low on Traditionalism tend to prioritise freedom, self-direction, as well as pleasurable and stimulating experiences. Universalism in particular has been associated with pro-environmental attitudes and behaviours (Schultz et al. 2005). The basic human values were measured using the Portrait Value Questionnaire 21 (PVQ–21, Table S. 7.6) translated and validated for use in Brazil (Sambiase et al. 2014), and transformed to the Universalism and Traditionalism dimensions using fixed equations (Table S. 7.3.) (M. Strack, unpublished), derived through exploratory factor analysis approach (Strack & Dobewall 2012) applied to PVQ21 data from first the five waves of the European Social Survey.

Economic factors included income and scarcity experienced in childhood. Income was assessed at household level, those in the lowest income quartile were classified as income poor, others as not-poor. Scarcity in childhood was measured with the question: "When you were a child, did you ever experience difficulty obtaining food and/or

medicines?". Answers "never" and "sometimes" were classified as "low frequency", answers "often" and "almost every day" as "high frequency". Socio-demographic factors included age, gender, and education. Household remoteness (measured as travel distance from Altamira) was included as a proxy for access to markets, services and health infrastructure. Forest cover was included as a proxy for the "amount" of nature remaining in the household's neighbourhood; it was calculated using Global Forest Change maps (Hansen et al. 2013) (Appendix 3 – Chapter 3 Supplemental methods, modelling and analysis). We also collected complimentary qualitative data by recording comments relating to questionnaire statements, and through several opportunistic semi-structured interviews. Research was approved by the Lancaster University Research Ethics Committee (RS2015/68).

Data were analysed in R v.3.3.3 (R Core Team 2018). Packages glmmADMB v.0.8.3.3 (Skaug et al. 2016) and MuMIn v.1.40.4 (Bartoń 2018) were used to generate and select generalised linear models, separately for each attitude (SI). Before running the models, predictors were checked for multicollinearity; no issues were identified as all VIF values were below 1.5. Additionally, nature connection measures and values were correlated; lack of significant correlations verified that they can be treated as independent predictors of attitudes in our models (Table S. 7.4). Global models included all the above predictors. Attitude responses were modelled as a binomial process (Allik 2014); due to over-dispersion we used beta-binomial distributions. Predictor effects were deemed significant when their 95% confidence intervals did not cross zero; predictors' importance was compared based on the number of models for different attitudes in which it appeared as significant.

3.4 RESULTS

Overall, we interviewed 241 adults (58% males), aged 18 to 75 (mean 47.0, SD 13.4), from 147 properties. Most respondents had primary school level education (median education was 4 years); 12% had completed high school, 4% had at least some higher education, whereas 13% had no formal education. Nearly half of respondents (44%) had grown up in Pará and the neighbouring state Tocantins, others had migrated from elsewhere in Brazil. None self-identified as indigenous. Smallholders (≤100ha) represented 51% of interviews, medium landholders (101- 600ha) 46%, and large

landholders (>600ha) 3% – proportions broadly representative of the region (Godar et al. 2012). General attitudes were largely pro-conservation except for preferences to control wildlife. Relatable and benign species were more widely tolerated than those considered unappealing and dangerous (Figure 3.2.).

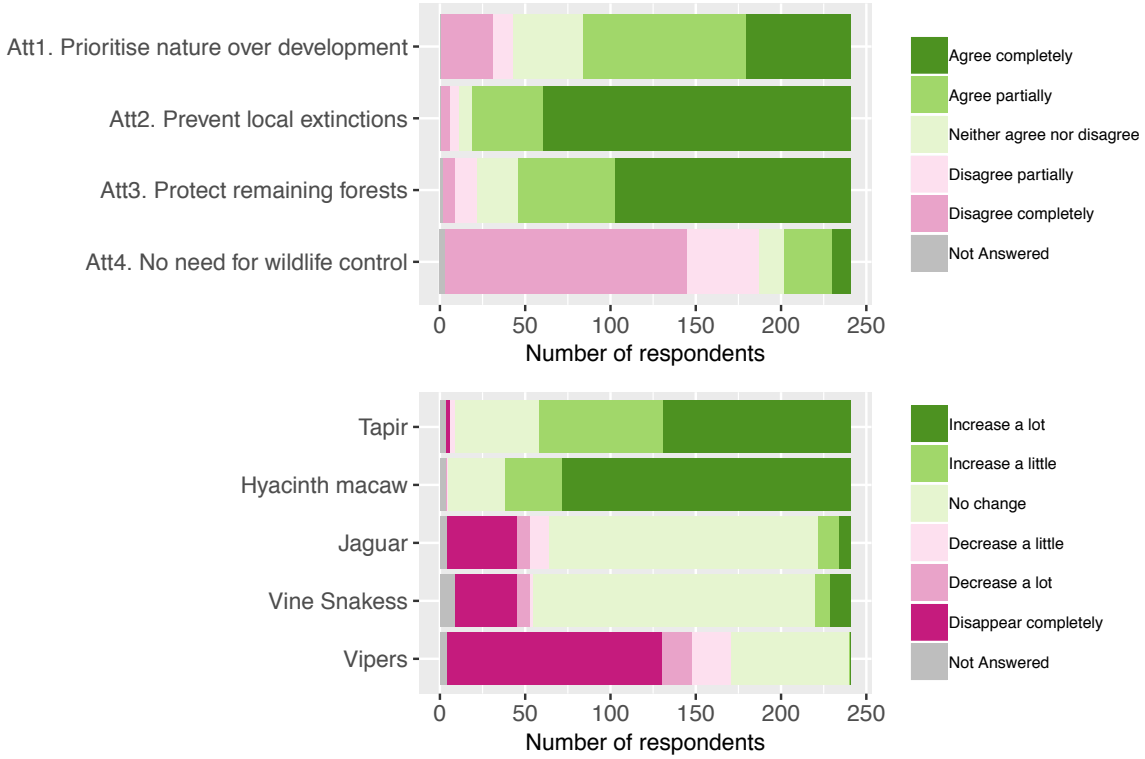

Figure 3.2. Distribution of attitude responses.
Upper panel: general attitudes; lower panel: tolerance to species.

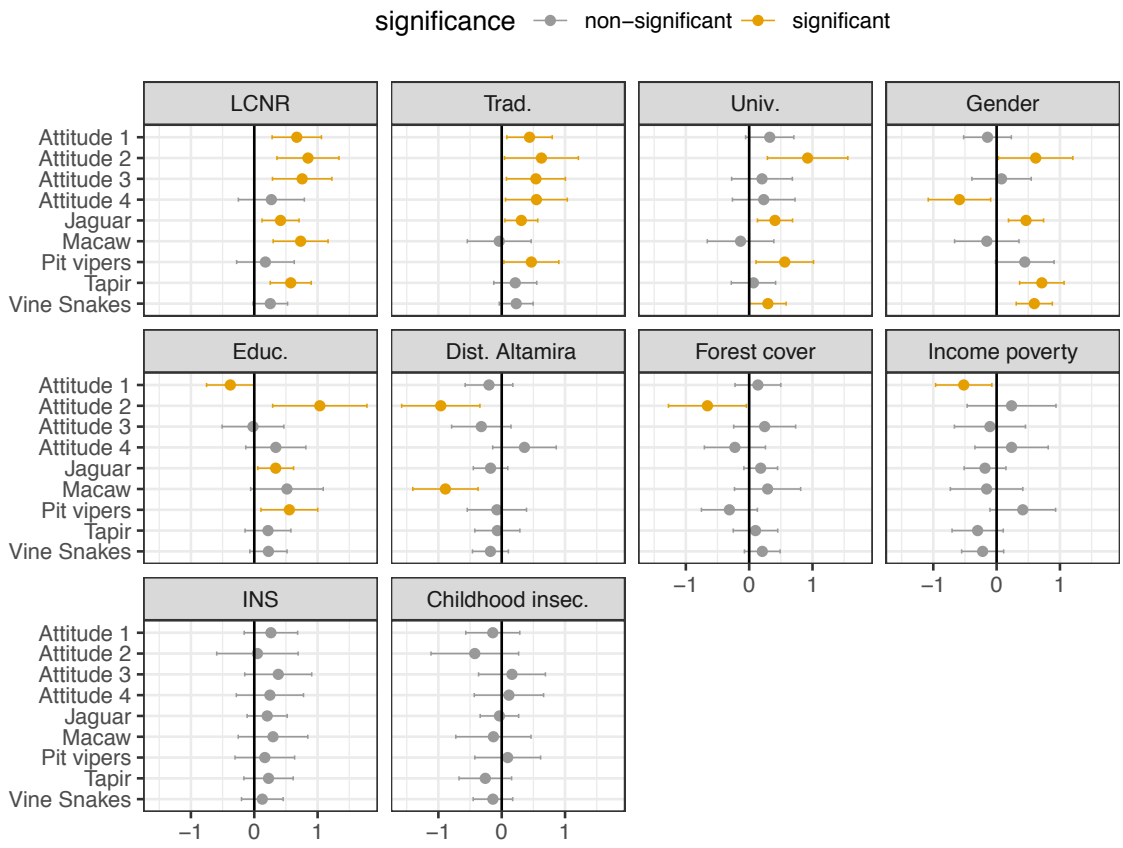

Figure 3.3. Estimated associations between predictor variables and conservation attitudes based on averaged models.
Error bars represent the 95% CI.

We found a positive association between affective (but not cognitive) CWN and pro-conservation attitudes in this novel, tropical setting. LCNR was positively associated with six out of nine attitudes; more than any of the economic, socio-demographic, and environmental factors (Figure 3. 3). Values appeared equally important as LCNR, with Traditionalism also associated with six attitudes, although each predictor was associated with a unique set of attitudes. LCNR related to all attitudes except tolerance of snakes and support for controlling damaging wildlife. Traditionalism was associated with all except tolerance of benign species. Universalism explained four attitudes, positively associating with tolerance of dangerous and/or unappealing animals, support for preventing extinctions, and disapproval for development over nature protection. Gender was also important; men were more tolerant of tapirs, jaguars and vine snakes, and more supportive of preventing local extinctions, but simultaneously less opposed to controlling wildlife than women. Education enhanced tolerance of dangerous animals

and support for preventing extinctions but was also associated with preference for development over nature protection. Economic factors and geographic covariates explained relatively little. However, income poverty enhanced support for development over nature. Distance to the sub-regional city Altamira was negatively associated with tolerance of macaws and support for preventing local extinctions; the latter was also negatively associated with forest cover. The remaining variables, including INS, were not significantly related to any attitudes.

3.5 DISCUSSION

In a first study of CWN and environmental attitudes in the tropics, we have shown that affective CWN was a key predictor of pro-conservation attitudes. The contribution of this finding is two-fold. First, it challenges the conventional, institutionalised wisdom that the world's non-indigenous poor either do not care about environment at all, or only in as much as it contributes to their material needs. Previous research has demonstrated that a relationship between GDP and environmental concern does not hold consistently across countries (Dunlap & York 2008). Our case study from an Amazonian deforestation frontier shows that at the individual-level, socio-psychological factors trump economic ones in shaping conservation attitudes. Consistent with the findings of Dunlap and York (2008), the single attitude decidedly influenced by an economic factor (income poverty) was the only one involving an explicit potential trade-off in economic opportunities for the respondents. This suggests that intrinsic motivations may play a significant role in promoting support for conservation in poor regions, not just in the wealthy nations. Second, our findings support the applicability of the Western-developed concept of CWN, especially the affective CWN, as a basis for a broad conservation ethic, including in the rural tropics (this thesis, Chapter 1, Zylstra et al. 2014). The lesser importance of cognitive CWN in explaining the attitudes may be real, or an artefact of the selected measure (chosen for its simplicity); INS has consistently showed somewhat lower correlations with attitudes and behaviours than other measures of CWN (Tam 2013).

Our study also sheds some light on the differences in the ways in which CWN and values may shape conservation views. Although affective CWN, Traditionalism, and Universalism all promoted pro-conservation attitudes, the specific attitudes they were

associated with differed. These differences related mainly to wildlife tolerance. In line with adaptive explanations for CWN, LCNR played a role in tolerance of all species except snakes, suggesting that most people fail to extend their sense of CWN to include those elements of nature we may be evolutionarily primed to fear, such as snakes (Barrett & Broesch 2012). For rural Amazonians, a fear of snakes is also often reinforced through experience, given the high prevalence of snakebites, often deadly (Feitosa et al. 2015). Tolerance of jaguar – a potentially dangerous (Campos Neto et al. 2011) but charismatic mammal – was encouraged by LCNR, Traditionalism and Universalism, but only the latter two also promoted tolerance of snakes, and only LCNR promoted tolerance of tapirs and macaws. Thus, affective CWN may be the main mechanism through which people develop caring for nature that they find relatable and appealing. Acceptance of less relatable wildlife may be more reliant on appropriate values. However, since values are notoriously difficult to change (Manfredo et al. 2017), CWN may offer a more attractive avenue for promoting a broader conservation ethic. CWN has been shown to be malleable to an extent and can be encouraged e.g. through contemplations of compassion and of nature's beauty, and repeated experiences of nature (Schultz & Tabanico 2007; Lumber et al. 2017). Indeed, the consistent gender difference in tolerance in our study may be due to men's greater familiarity with wildlife, as they spend more time in fields and forests than woman, whose tasks are traditionally more home-bound. The positive relation between education and tolerance of snakes further suggests that tolerance of unappealing wildlife and support for preventing extinctions can be somewhat encouraged through education.

Whilst the positive association between Universalism and pro-conservation attitudes was consistent with previous studies, the stronger positive association with Traditionalism was more surprising. In Western countries, Traditionalism, related to security and preservation of the status quo, is usually negatively associated with pro-environmental attitudes (e.g. Schultz & Zelezny 1999). However, this finding is also consistent with Dunlap's thesis. Likewise, high overall scores on both Universalism and Traditionalism suggest that support for conservation is not associated with purely 'post-materialist' values, which are generally characterised by high Universalism and low Traditionalism. In our rural tropical research context, we interpret the positive relationship with many pro-conservation attitudes to suggest that nature may be seen as a security asset or part of the valued order of things. Living in close proximity with

nature, tropical farmers may be keenly aware of their reliance on natural ecosystems. Indeed, numerous respondents expressed concern that deforestation may be causing the rising temperatures and droughts they increasingly experience (Table S. 7.2), which is in line with scientific evidence (Spracklen & Garcia-Carreras 2015).

It is important to note that, although respondents expressed support for pro-conservation views, agreement with different attitudes was not homogenous. Tolerance of different species followed the predicted order dictated by species perceived charisma and danger to humans. The general attitudes were expected to show greater internal consistency, yet we see that support for attitudes 2 and 3 was much greater on average than that for attitudes 1 and 4. This may be because the latter pair explicitly expressed a trade-off between conservation and economic interests, whilst the former did not. Face validity of attitude 4 may have been compromised, because respondents seemed to variously interpret "control" to mean lethal or non-lethal measures. Nonetheless, it shows a widespread desire among the respondents control wildlife in one way or another to prevent damages to crops or people. Overall, it appears that support for different conservation attitudes may be influenced both by intrinsic motivation and by the perceived cost and the salience of this cost associated with each measure.

The apparent interplay of intrinsic motivations and costs in shaping conservation attitudes implies that the extent to which CWN may promote pro-conservation views and actions may be constricted for costly behaviours. This view is supported by the qualitative comments, which revealed barriers restricting effective forest conservation on farms (Table S. 7.7). The most common one was the perceived lack of viable economic alternatives to deforestation (Meijer et al. 2016). Farmers frequently expressed a sense of internal tension at feeling unable to simultaneously meet their families' subsistence needs and preserve as much forest as they would like. Some respondents also did not feel responsible and obliged to follow legal restrictions on deforestation if they felt they were not fairly applied to all actors, including large landholders, whose negative impact they thought was much greater (Kahn Jr 2003). Importantly, farmers intrinsically motivated to conserve nature often expressed discordant attitudes towards management practices, such as the acceptability of selective logging for sale, due to differences in beliefs about whether the activity was harmful to nature (Schroeder 2005).

3.6 CONSERVATION IMPLICATIONS

Our analysis demonstrates that pro-conservation views are widespread among non-indigenous Amazonian farmers and shaped primarily by affective CWN and values. Hence, this study suggests that nature protection may not only be an important concern for the rural poor in the tropics, but also that intrinsic motivations may play a significant role in stimulating this concern. These results directly contradict decades-old assumptions underlying environmental protection thinking at major hegemonic institutions such as the World Bank and International Monetary Fund (Dunlap & York 2008). They also resonate with important current debates about the valuation of nature's benefits to society. Specifically, they support the broad inclusive approach taken by the IPBES, which attempts to consider on an equal footing the intrinsic motivations for nature protection emphasised by some stakeholders and the utilitarian motives highlighted by others (Masood 2018).

Our findings have some important conservation implications. First, conservation interventions should be carefully designed to ensure that existing intrinsic motivations are not "crowded-out" and supressed, e.g. by utilitarian motives inadvertently encouraged by some PES schemes or by perceptions of unfairness of environmental laws and their enforcement (Rode et al. 2015). Second, efforts to strengthen affective CWN may indeed prove an effective way to encourage greater intrinsic motivations and kinder a conservation ethic. Whilst a particular behaviour may be more fruitfully targeted by behaviour-specific interventions (St John 2018), a broad conservation ethic may be especially important to sustain complex behaviours stretched over time, such as the adoption of novel environment-friendly farming systems (Zabala et al. 2017). We propose that CWN provides a useful theoretical and empirical framework for efforts to understand, and potentially promote intrinsic motivations for conservation in the tropics.

Nevertheless, our results highlight that intrinsic motivations do have their limits. They must be accompanied by enabling systemic structures in order to manifest themselves as meaningful conservation action (Abson et al. 2017). Holistic strategies focused on encouraging intrinsic motivations, targeting behaviours of interest, and removing behavioural barriers to make it easier for people to act accordingly to their pro-

conservation intent appear to hold most promise for conservation success. Finally, our results highlight the need for more research on the links between intrinsic motivations and conservation actions, so we can move beyond individual case studies and formulate general principles that can guide more effective conservation policies.

ACKNOWLEDGMENTS

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4 “What’s love got to do with it?” Untangling connection with nature and ecological knowledge at an Amazonian deforestation frontier

§ "What's love got to do with it?" Untangling connection with nature and ecological knowledge at an Amazonian deforestation frontier.

AUTHORS: Katarzyna Mikołajczak, Alexander C. Lees, Jos Barlow, Frazer Sinclair, Oriana Trindade de Almeida, Agnis C. Souza, Luke Parry

4.1 ABSTRACT

Many conservation scientists and practitioners appear to tacitly assume that a caring relationship with nature, known as connection with nature, is strongly linked to ecological knowledge. Here, we question this assumption, since existing evidence is inconclusive, limited to Global North countries, and does not adequately examine drivers of ecological knowledge and connection with nature. We investigate the relationship between ecological knowledge – measured as the ability to identify common bird species – and connection with nature among a farming community around the Transamazon Highway – a major Amazonian deforestation frontier. We provide baseline levels for ecological knowledge and potential drivers of ecological knowledge and connection with nature in our study context. We show that knowledge and connection are unrelated and associated with different predictors in our study population. Hence, our study provides evidence that ecological knowledge and connection with nature are not universally related, which has implications for the design of conservation outreach activities. Additionally, we draw attention to the poor knowledge of forest bird species among our interviewees, which may be impairing effective conservation of local forest fauna.

KEY WORDS

Connection with nature, ecological knowledge, human modified tropical ecosystems

4.2 INTRODUCTION

The catastrophic biodiversity declines globally are accompanied by simultaneous loss of knowledge about natural ecosystems, both within traditional and non-traditional societies (Miller 2005; Aswani et al. 2018). This raises concerns that the loss of this ecological knowledge not only undermines people's ability to manage ecosystems, but

also their interest and willingness to protect them. The assumption that caring for nature rests on knowledge and understanding of the natural world can be traced at least as far back as the 1960s, to a popular quote by the Senegalese forestry engineer Baba Dioum: "In the end we will conserve only what we love, we will love only what we understand, and we will understand only what we are taught" (1968). These powerful words encapsulate a belief that appears pervasive within conservation science in academia and among some conservation NGOs (see examples in Table 4.1.). Indeed, deep care and love for nature have been shown to be a potent driver for engagement in pro-environmental behaviours (Perkins 2010; Geng et al. 2015). But do we "only love what we understand?"

In this paper we question whether caring for nature is in fact linked to ecological knowledge (EK). Current literature on this topic presents several outstanding research gaps. First, existing papers explicitly examining the relationship between ecological knowledge and nature caring are recent and few, and the evidence is mixed. This may be due to inconsistent application of objective measures of ecological knowledge and rigorous psychological methods. Furthermore, current evidence is limited to the Global North only and may be specific to this cultural context. Despite the recognition that conservation often hinges upon the knowledge and cooperation of local people (Berkes 2004), very few studies focus on EK and caring for nature among rural populations, particularly migrant ones, in the Global South. As a result, there is a dearth of even baseline information regarding the levels and drivers of EK and caring for nature in human populations living within or neighbouring many important biodiversity areas. Thus, it is unclear whether the proposed positive link between EK and caring for nature is universal, whether they share any common drivers, and what kind of conservation outreach campaigns are likely to promote both simultaneously.

Table 4.1. Examples of the belief that caring for nature is related to ecological knowledge expressed in environmental NGO materials and academic papers

	Quote	Context	Source
NGO	"In the end we will conserve only what we love, we will love only what we understand, and we will understand only what we are taught"	Baba Dioum's words used as an inspirational quotation in an educational poster campaign for schools, WWF UK One Planet Schools "Learn" Programme.	WWF UK webpage (2018)
	"We approach our elephant work in the same spirit as Baba Dioum. Our endeavor to protect elephants is inspired by love and deep respect for them as a species and as individuals, which, in turn, is based on our understanding of them gained through long-term study. "	Elephant Voices, quoting Baba Dioum at the top of the Education section of their webpage	Elephant Voices Webpage 2018
Academia	"People care about what they know."	Seminal study demonstrating that children in the UK had greater ability to identify synthetic Pokémon „species" than to name common British wildlife,	Balmford et al. (2002)
	"[T]he levels of ecological knowledge studied here (names of living components of ecosystems and the functions and uses of each component) provide an indication of a community's connectivity and willingness to care for the local environment, since naming things with which we are familiar is human instinct and we are unlikely to care about that which we do not know" (p.1007).	Influential cross-cultural study demonstrating an inverse relationship between levels of ecological knowledge and wealth measured at the level of nation and community	Pilgrim et al. (2008)
	"[The] loss of familiarity and knowledge [of nature] is cause for profound concern as it may lead to reduced appreciation of the natural world, reduced motivation to protect species, [and] less willingness to support nature (…)."	Study exploring socio-demographic factors influencing plant identification knowledge among adults in UK	Robinson et al. (2016)
	"People who care, may make choices to conserve; but people who don't know [nature], don't even care. What is the extinction of a condor or an albatross to a child who has never known a wren?" (p.207)	Influential opinion piece emphasising the need for fostering deep connections to nature.	Pyle (2003)
	"Natural history, the scientific study of plants and animals in their natural environments, is the cornerstone of ecological literacy. It not only instructs in the knowledge of place but instills an emotional enthusiasm and empathy toward natural phenomena." (p. 118)	Study highlighting deficient levels of natural history knowledge among university students in Mississippi, including those with course work in ecology	Hammond & Herron (2012)

Psychological research points out that a deep sense of love and caring for nature is an inherent part of the concept of connection with nature (CWN) – the extent to which we feel we belong to nature and feel emotionally attached to it (Perkins 2010; Zylstra et al. 2014). CWN has been operationalized in over a dozen related, validated measures (e.g. Chapter 2, this thesis. see Restall & Conrad 2015 for a review of measures for nature connection and related concepts). Therefore, validated CWN scales may be the preferable tool for measuring differences in caring for nature, as opposed to ad-hoc measures of CWN or attitudes, which tend to be more object-specific (e.g. birds) and less generalizable than CWN. However, existing studies have tended to use rigorous measures of either ecological knowledge or of nature connection, but not both simultaneously, which may have led to the conflicting results they produced.

For example, three studies demonstrating a positive relationship between EK and caring for nature (Hammond & Herron 2012; Cox & Gaston 2015; White et al. 2018) have used objective measures of ecological knowledge about common native species, yet non-validated measures of caring for nature. These studies have found that i) university students in Mississippi with higher self-reported "environmental sensitivity" (defined there as "having empathy for or relating to other living things or nature in general", p. 120), held more knowledge about identification and ecology of local fauna and flora than their peers (Hammond & Herron 2012); ii) the extent to which people in the UK liked different bird species and "felt connected to nature when watching birds in their gardens" was positively related to their bird identification skills , and iii) bird identification knowledge and positive attitudes towards birds among schoolchildren in the UK were positively correlated, although changes in attitudes and changes in knowledge following a six-week bird feeding and monitoring programme did not correlate. In contrast, using a variety of methods including online surveys and a quasi-experimental intervention based around a nature walk, Lumber et al (2017) found that knowledge-based activities were ineffective pathways to increase caring for nature, measured using a validated CWN scale. Instead, connection responded better to activities based on finding contact, emotion, beauty, compassion, and symbolic meaning in engagements with nature. However, Lumber et al (2017) measured only the engagement in activities related to studying or "finding out more" about living organisms, and how much participants valued being able to engage in these activities. Since EK is often cumulative and can be transmitted through various forms of

engagement with nature (Olsson & Folke 2001; Almeida et al. 2018), not merely science-inspired ones, it does not have to correlate with engagement in such activities. A better test of the postulated positive relationship between EK and caring for nature would involve objective measures of EK and validated measures of CWN.

Both EK and CWN are recognised as being rooted in the different nature experiences that people have (Miller 2005; Clayton et al. 2017). However, the ways in which various environmental, social and geographic factors shape CWN and EK (presumably mediated by changes in experiences of nature) have been considered differently in the largely separate literatures on EK and CWN. Research on CWN has mainly looked at its direct relationship with the type and amount of nature experience, which we refer to in this paper as "nature-contact" factors. Several studies show positive associations between the frequency of past and present nature experiences and various measures of CWN (e.g. Kals et al. 1999; Soga et al. 2016). There is also evidence of a positive feedback loop, as people who visited natural spaces in childhood and those with higher CWN are more likely to continue visiting natural areas in adulthood (Lin et al. 2014; Rosa et al. 2018). Formal Western-style education, frequently (but not always) linked to losses of traditional EK among indigenous populations (Aswani et al. 2018, p.2), can also be considered a nature-contact factor. This is because it often reduces the time that children spend in natural areas, either alone or under the supervision of knowledgeable elders (Demps et al. 2015). Such lost opportunities for non-formal EK learning are rarely compensated by formal curricula, which do not tend to place strong emphasis on natural history knowledge and skills (Almeida et al. 2018). This contributes to the generally low levels of EK in places where formal schooling and Western lifestyles are the norm.

In contrast to CWN, changes in EK are considered mainly in response to broad-scale socio-environmental factors (Aswani et al. 2018). Some of the main postulated drivers of changes in EK include modernization (spread of tech, urbanisation, modern health services) and market integration. Such factors have the tendency to lower people's direct reliance on natural ecosystems and the need for intimate knowledge of the local environment. Hence, they are generally associated with lower average EK levels (Pilgrim et al. 2008). We refer to them as "nature-reliance" factors. Declining biodiversity and the extent and quality of natural habitats, as well as reduced physical

access to natural areas have been linked to losses in EK, presumably through decreased opportunities to interact with nature (Miller 2005; Kai et al. 2014; Barreau et al. 2016). We call these "nature-access" factors. Beyond these broad drivers, differences in EK and CWN have often been associated with socio-demographic factors such as gender, age, and culture, however the directions of these associations are usually context specific, since they can be underpinned by various mechanisms.

Although most research on CWN to date has been conducted in the Global North, understanding what factors contribute towards greater caring for nature is, potentially, vital for conservation efforts worldwide. Many of the biodiversity-rich forest-agriculture frontiers in the tropical Global South are characterised by remoteness, a weak influence of the state and the presence of multiple landholders or land-occupiers (whether legal or not), whose individual decisions collectively shape landscape composition and conservation value (Fearnside 2008). Relative to places with a strong rule of law, uncertain or weak enforcement could entail greater influence of residents' own preferences on their land management decisions. Although deforestation decisions are undoubtedly primarily motivated by micro-economic considerations, internal motivations, such as caring for nature, also matter, and may become particularly important as the frontier ages (Chapter 3, this thesis; Garrett et al. 2017; Zabala et al. 2017). People with higher intrinsic care for nature and a sense of responsibility for it may be more engaged in conservation, for example by setting aside more forest for protection on their land than their peers, or by voluntarily undertaking policing of their properties against illegal timber cutting and hunting activities. Local EK patterns among migrant farmers at rural forest frontiers are also poorly known but are likely different to those of traditional and indigenous rural populations. This is due to lifestyle and cultural differences, and because by definition, migrants cannot easily rely on inter-generationally accumulated traditional knowledge and have to learn about their new local environment themselves. Since many conservation outreach activities seem to rely heavily on promoting factual EK as a way of boosting pro-conservation views among their target audiences (e.g. Howe et al. 2012; Vieira et al. 2016), insights into the local nature of the EK-CWN relationship could help to more effectively tailor conservation engagement programmes.

To begin addressing these research gaps, we investigated the relationship between ecological knowledge and caring for nature in the Transamazon Highway region. This area is one of the deforestation frontiers that typifies the 1960s and 1970s plans of the Brazil's military government to colonise and connect vast tracts of previously nearly inaccessible and allegedly "empty" parts of Amazonia with the rest of Brazil in order to "integrar para não entregar" (integrate to not hand over). This was achieved through large-scale construction of several key roads joining the reminder of Brazil's road network, and assisted in-migration of thousands of farming families from other states to cultivate the settled land. Our study focuses on the mostly farming population inhabiting the region today. We employed a robust sampling design, used two validated, independent measures of CWN as indicators of caring for nature, and developed an objective measure of species identification skills as an indicator of EK. We aimed to i) provide a baseline description of the EK levels (CWN levels in this dataset have already been identified, Chapter 2, this thesis), and EK and CWN drivers at the Transamazon deforestation frontier, ii) identify the correlation between EK and CWN measures, and iii) identify any potential shared geographic, socio-demographic, experiential, drivers.

4.3 METHODS

4.3.1 Study Site

Our study area, located around the Transamazon Highway in the south-eastern Brazilian Amazon in the municipalities of Brasil Novo, Medicilândia and Uruará in Pará state (see Figure 4.1.), is a prime example of a tropical forested region under threat from deforestation, fragmentation and degradation. It was sparsely populated and almost completely covered with old-growth forest prior to the early 1970s, but has since lost ca. 30% of its forests , as the highway was built and the area became one of the most emblematic sites of the military government's colonisation scheme (Moran 1981). Today, we can define this areas as a "maturing deforestation frontier"; after four to five decades from initial colonisation it has intermediate levels of market accessibility and forest cover as compared to new frontiers and post-frontier areas (Schielein & Börner 2018). The rural part of this sub-region is a mosaic of agricultural land, forest fragments, and forest reserves, inhabited by thousands of predominantly farming families. Most of the local roads and much of the highway itself remain unpaved, which makes them hard to maintain in the tropical climate, particularly in the wet season (ca. October to May).

Poor road infrastructure means that much of the area still remains relatively remote and hard to access from major cities. Despite strict forest-protection laws and hunting regulations (Soares-Filho et al. 2014; El Bizri et al. 2015), the state in much of Amazonia is weak and enforcement difficult and patchy. The rapid socio-environmental changes accompanying the colonisation of the Transamazon Highway frontier over the past half century have resulted in large variation in local forest cover, proximity to local or larger urban centres, and heterogeneous reliance on forest subsistence foods. Consequently, there is likely to be marked variation in terms of experiences of nature that the local farmers have had.

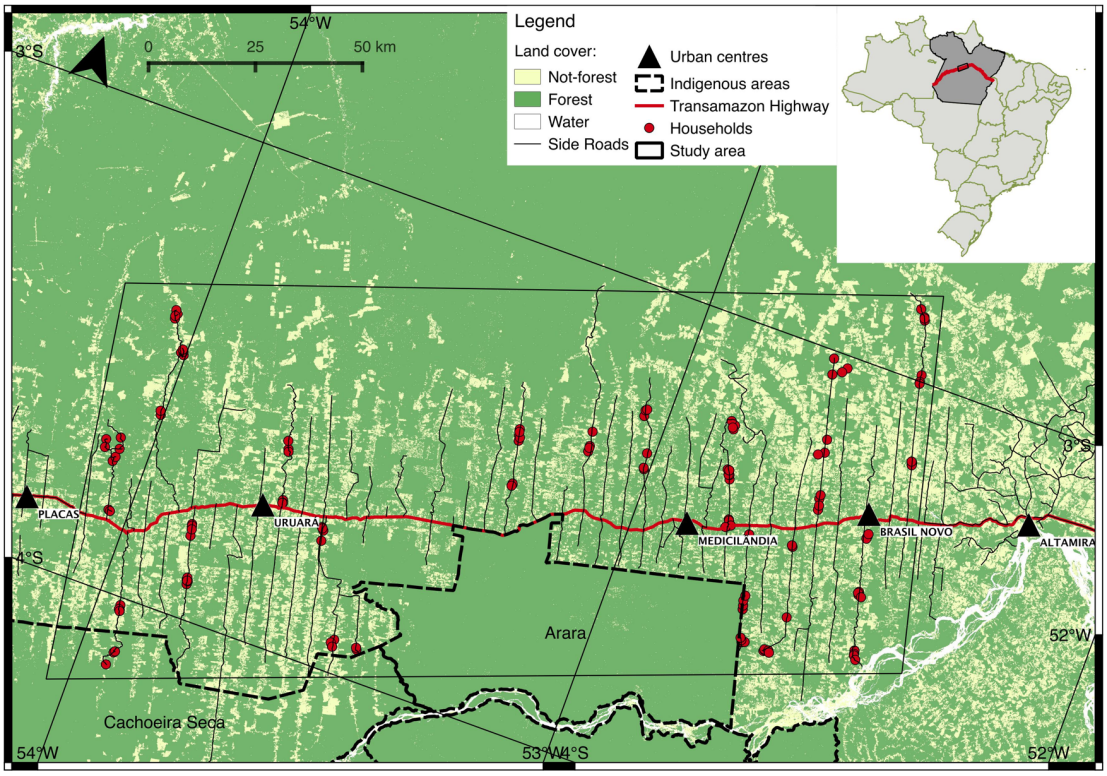

Figure 4.1. Map of the study area.
Inset map shows location within Brazil. The bounding box covers ca. 17.838 km2.

4.3.2 Study design and questionnaire application

Sampling was stratified so as to capture a wide range of local forest cover and distances from the sub-regional urban centre Altamira (Table 4.2). Forty-five sampling points were selected along 15 of the "fishbone-like" side-roads running perpendicular to the highway, three points per each side-road (details in Chapter 2). Six of the sampling points were later abandoned due to access difficulties or apparent lack of inhabitants.

At each sampling point we attempted to interview male and female heads of four families (or close family if involved on the farm) owning properties closest to the sampling point. If we were refused (n = 23 households) or the owners were unavailable (n unrecorded), we attempted interviews at the next closest household, and so on. Overall, we interviewed 241 adults from 147 farms. Following prior, informed consent, questionnaires were completed in face-to-face interviews in Portuguese. Besides measures explored in this study, questionnaires included data on economic status, socio-demographic characteristics, and attitudes and beliefs regarding agriculture and nature conservation in the area. The research was approved by the Lancaster University Research Ethics Committee (RS2015/68).

Table 4.2. Descriptive statistics of the sampled households: travel distance from the main city Altamira, travel distance to nearest town, and forest cover within 500m from the household.

	Mean	SD	Min	Max
Distance to Altamira (km)	141.6	72.64	41.98	261.50
Distance to nearest town (km)	21.48	12.33	0.98	54.45
Forest cover (%)	51.00	18.00	14.00	93.00

4.3.3 Ecological knowledge measures

As our measure of EK we investigated the ability to recognise local bird species. EK is obviously more complex than an ability to recognise and name species (Olsson & Folke 2001), yet species names represent labels that link species attribute information with their respective environments (Pilgrim et al. 2008). We chose birds as they are a globally ubiquitous taxon which is relatively easy to identify for non-specialists, represents little utilitarian value locally (only some species are regularly hunted), and thus we consider them a good proxy for general natural history knowledge. The species in the sample were chosen to be relatively common locally (Lees et al., 2013, A. C. Lees unpublished abundance data for the neighbouring region of Santarem, Para), not commonly hunted or persecuted (although some species are prized as song birds), and relatively easy to identify in the field (pre-selecting where possible species for which visual separation from sympatric congeners is easy without binoculars) from across the avian tree of life.

Participants were asked to name species from two bespoke plates with photographs of 19 birds: 13 non-forest species and 6 forest-associated species (Table S. 7.8). To

account for the possibility that some birds may be more familiar to local people by sound than by sight, we then played calls of a sub-sample of eight species (5 non-forest and 3 forest) with easily-recognisable songs and calls and asked the participants to name the species. Lastly, to account for the possibility that respondents, particularly migrants, may recognise species but not necessarily know their common names, we asked the participants to match the recorded calls to the images. Thus, we obtained three complementary – but not fully independent – measures of bird recognition. The call recordings were obtained from an open-source community bird sound database (www.xeno-canto.org) and photographs were sourced from Wildscreen Arkive (https://www.arkive.orgarkive.org), Encyclopedia of Life (https://eol.org) and Wikipedia (https://www.wikipedia.org/). If suitable open source or free-for educational-use suitable photographs were not available we used, with authors permission, photographs from Flickr (https://www.flickr.com) and Wikiaves (https://www.wikiaves.com.br).

4.3.4 Bird names scoring

Names were written down phonetically in the field, and then matched against standardised lists of Brazilian vernacular names for target species as defined by Brazilian Ornithological Records Committee (CBRO) (Piacentini 2015), with additional local names taken from Avibase (https://avibase.bsc-eoc.org). Matching names, or close onomatopoeic variations (e.g. “arapurú” as a variation on “uirapurú” [Cyphorinus arada]), were scored as correct at species level. If a proposed name did not match any of the already listed names for the species in question, we performed further searches on these databases and on YouTube (https://www.youtube.com/), listing all species that matched the name or its onomatopoeic variations. Names associated with YouTube videos portraying the target or related species (n = 5) were scored as correct at the appropriate taxonomic level (e.g. we accepted “peito-de-aço” as a valid local species name for Lipaugus vociferans based on the title of a clear video footage from Pará portraying a singing individual, where video author also refers to the bird as “peito-de-aço”). Names matching species from the target species’ genus either from CBRO, AviBase or on YouTube, were scored as correct at the genus level. Owing to the diverse origins of the participants in our sample, the respondents identified many birds with a variety of vernacular names, particularly those open-area genera that occur throughout Brazil.

4.3.5 CWN measures

Connection with nature was scored by two independent methods. Cognitive CWN (the extent to which one believes themselves to be part of nature) was measured with the Inclusion of Nature in Self scale, a single-item graphic instrument depicting seven Venn-diagrams of two progressively overlapping circles representing 'self' and "nature". To measure INS, participants were asked "The two circles indicate you and nature. Please indicate which of these drawings best represents your relationship with the natural environment. How connected are you with nature?". Affective CWN (emotional attachment to nature) was measured using the LCNR scale: a 7-item Likert-like scale, with responses measured from 1 = "Completely disagree" to 5 = "Completely Agree", aimed to capture feelings of love, caring, awe and psychological wellbeing derived from nature (Chapter 2, this thesis). Both measures have been successfully tested for use in our study area (Chapter 2, this thesis).

4.3.6 Determinants of experience

The explanatory variables included a selection of nature-contact, nature-reliance, and nature-access indicators, as well as socio-demographic factors. Nature contact was indicated by years of formal education (negative indicator), current frequency of nature contact and childhood frequency of nature contact. Indicators of direct reliance on nature included a forest subsistence index, travel distance to regional city Altamira, and travel distance to the nearest town. Nature access was indicated by per cent forest cover within a 500m buffer around the house and calculated based on Global Forest Change maps (Hansen et al. 2013) (Appendix 5 – Chapter 4 Supplemental methods). Socio-demographic variables included age, gender, and origin (whether participant grew up in an Amazonian state or elsewhere).

Current frequency of nature contact was assessed with the question: "How often do you spend time in nature: in a forest, at a river or lake?". Responses were recorded in the form of frequency of times per week, month, or year as most appropriate, and coded into 8 ordered categories ("Almost never", "1-2 times a year", "3-4 times a year", "Once or less per month", "2-3 times per month", "1 time per week", "2-3 times per week", and "Almost every day"). Childhood contact with nature was assessed with the question: "When you were a child, how often did you spend time in nature: in a forest, at a river

or lake?". Responses were measured on the scale 1= "Almost never", 2= "Sometimes", 3="Often", and 4="Almost everyday".

The forest subsistence index was based on the rank importance given to three types of forest-based products (bushmeat, self-caught fish, and non-timber-forest-products, especially brazil nut, bacaba palm nuts, and açai berry) as food sources. Respondents were asked which activities were typically undertaken by their household to obtain food and/or income, against a list of common activities, with option to add new ones. Next, they were asked to rank the activities the household performed in terms of importance as a source of alimentation for the household, starting with 1 for highest importance. The maximum number of activities listed by any household was eight. We assigned number 9 to denote an activity not undertaken by a household for food and reversed the ranking order so that higher ranks would positively scale with importance. The ranks for bushmeat, fishing, and non-timber for products use were summed to obtain the forest subsistence index.

4.4 Analysis

Data cleaning, checking for consistency, and all the statistical analyses were conducted in R version 3.5.1. (R Core Team 2018). The different EK measurement methods and species name scoring methods were compared through Pearson correlations (Appendix 5 – Chapter 4 Supplemental methods). Pearson correlations between continuous predictors were no larger than 0.25, except age and education ($r = -0.38$). Multicollinearity was assessed using the imcdiag function with the Variable Inflation Factor (VIF) method in the mctest package ver 1.2 (Imdadullah et al. 2016), no VIF value exceeded 2.0. The relatedness between CWN and EK measures was assessed using Spearman correlations. Generalised linear models with beta-binomial error distribution were fitted separately for LCNR, INS, forest-birds EK, and non-forest birds EK as outcome variables, using package gamlss ver. 5.1(Stasinopoulos & Rigby 2007). The models were run on complete cases data.

4.5 RESULTS

4.5.1 Participant characteristics

A total of 241 respondents from 147 properties participated in our study and complete case data included 227 respondents. Participants were aged 18 to 75 (mean 47.0, SD 13.4); 13% had no formal education, most (71 %) had at least some primary schooling (median formal education was 4 years), 12% completed high school, and 4% completed at least some years in higher education. None of the participants self-identified as indigenous. The majority of the respondents (56%) grew up in non-Amazonian states, and the rest were raised in Pará and the neighbouring state Tocantins. Smallholders (≤100ha) represented 51% of interviewees, medium landholders (101- 600ha) 46%, and large landholders (>600ha) 3% – which roughly corresponds to their regional frequency distribution (Godar et al. 2012).

4.5.2 Bird species recognition.

Local knowledge of open-area species was moderately high, whereas it was generally poor for forest-dwelling species. Depending on the method (image, sound, image-sound matching), the respondents recognised on average 46 to 61% of open-area species and 12 to 16% of forest-dwelling species (Figure 4.2.). Knowledge of open-area birds showed a rather normal distribution, whilst knowledge of forest-birds was highly skewed, with the majority of respondents able to recognise very few species (Figure 4.5.). Different name scoring methods were highly congruent with each other ($r = 0.96$ to 0.99), whereas different bird identification methods were positively correlated ($r = 0.41$ to $r = 0.83$) but showed some differences (Figure S. 7.1. and Figure S. 7.2.). Therefore, for further analysis we used scores summed for bird recognition by image, sound, and sound-image matching, with image and sound recognition scored at genus level. This produced a measure less biased towards a single identification method, although more strongly weighted towards those species which were included in all three methods.

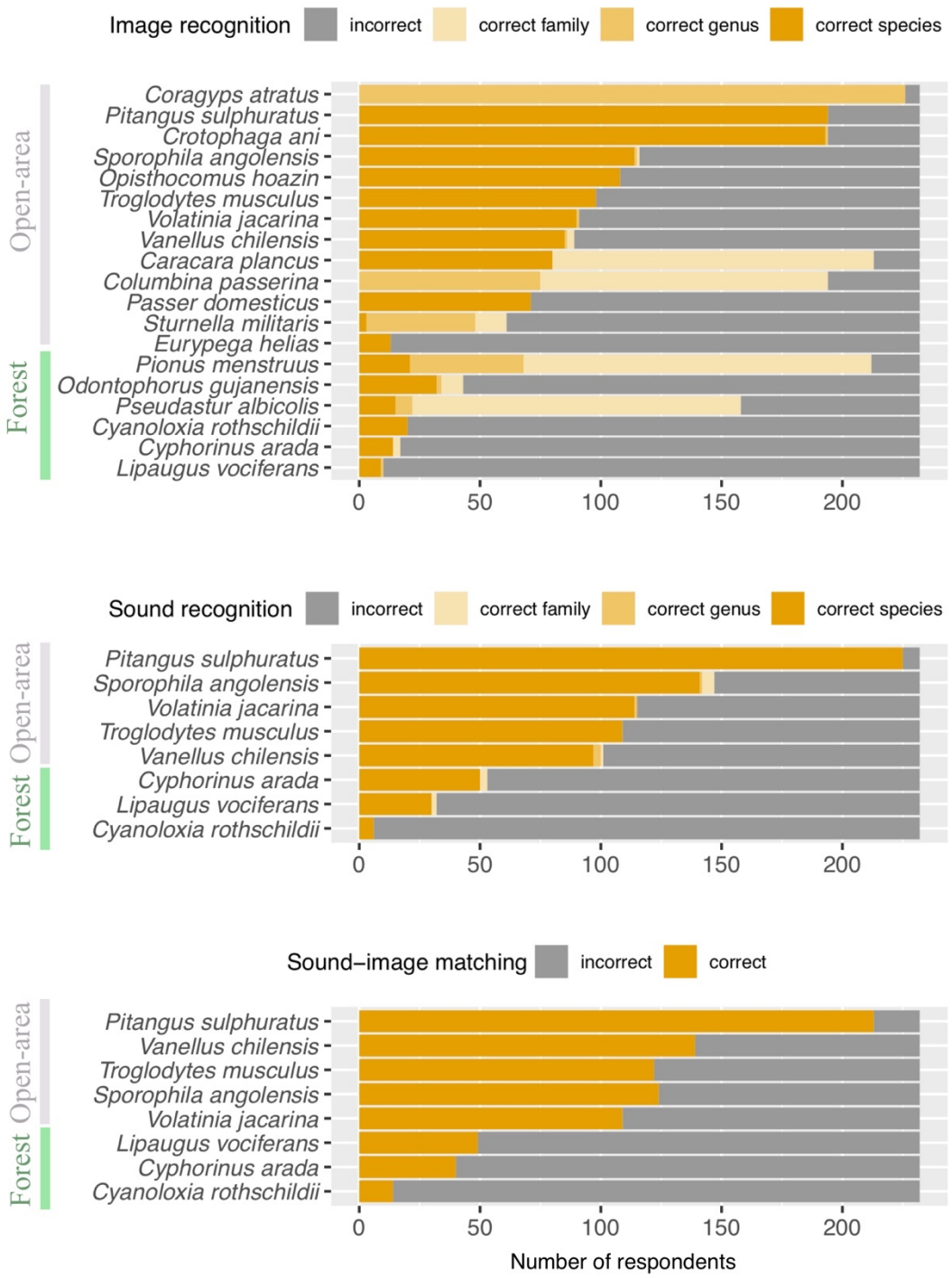

Figure 4.2. Recognition of bird species based on images, sounds, and sound-image matching.
Species were ranked by whether they were open-area or forest associated species, and then by the combined total of the correct genus and species level identifications.

4.5.3 Ecological Knowledge – Connection with Nature relationship

The two measures of nature connection – INS and LCNR – were significantly moderately-strongly correlated to each other (Spearman correlation = 0.47, $p < 0.001$), as were the two EK measures (Spearman correlation = 0. 44, $p < 0.001$), but neither pair

of CWN and EK measures showed any significant correlation (r = -0.08 to r = 0.06, all p >= 0.88) (Figure 4.3). Additionally, the distributions of CWN measures were similar to each other, with both showing a strong tendency towards the extreme-high values.

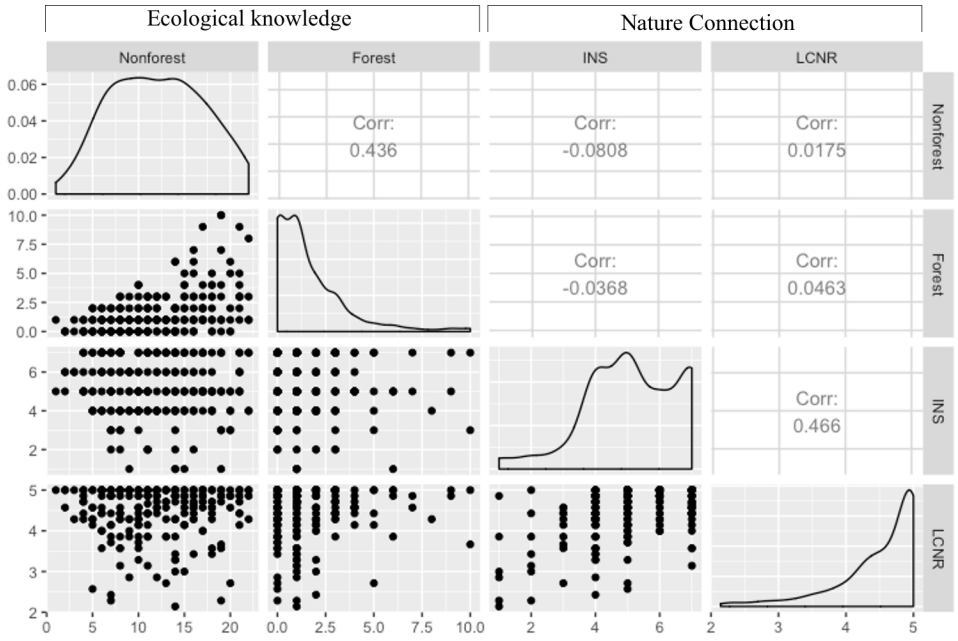

Figure 4.3. Pairwise correlations between ecological and knowledge nature connection measures.
INS = Inclusion of Nature in Self (cognitive CWN), LCNR = Love and Care for Nature – Rural (affective CWN).

Moreover, there was little overlap between factors predicting knowledge and connection (Figure 4.4). Nature access, as indicated by forest, showed – surprisingly – some negative influence on LCNR and open-area EK, yet these effects were not significant. The overall influence of nature-contact indicators on CWN measures, albeit not always significant, was consistent with our hypothesis, but had no effect on EK measures. Specifically, people who currently frequented natural areas more often reported higher INS and higher LCNR than those who rarely visited natural areas, though the latter effect was not significant. The frequency of childhood nature visits did not have a significant effect on any outcome variables. Education had a significant negative effect on connection, as expected, but only on the INS measure.

Regarding the the nature-reliance variables, forest subsistence index and distance to nearest town had generally neutral or positive but weak and insignificant effects on the

four outcome measures. The exception was the relationship between distance from nearest town and LCNR: people living further away from a market centre were significantly more connected to nature than those living closer by. It is worth noting that subsistence on forest products was low; the median score on the subsistence index was only 5 out maximum 27 (Figure S. 7.3), indicating that forest products were generally not of major importance for most people in our study population. Distance to Altamira showed patterns contrasting with the other two nature-reliance measures. Contrary to our hypothesis that distance to Altamira would show positive associations with EK and possibly CWN, people living further from this city were less emotionally connected to nature than average. The effect on the remaining outcome variables was also either neutral or weakly negative, though none crossed the significance threshold.

Socio-demographic variables, theoretically indicative of cultural and individual differences, were related both measures of CWN and EK. Older people were more likely to feel connected with nature, as measured either by CWN or INS, than younger generations, but were less knowledgeable about open-area species. Additionally, men were significantly more knowledgeable about both forest and open-area birds than women, although average knowledge of forest species still remained low (Figure 4.5.). There was also a weak, border-line significant effect of origin on CWN measures, with those people raised in Amazonia feeling more connected with nature than those who grew up elsewhere. Overall, low correlations and contrasting sets of predictors associated with EK and CWN measures indicate that knowledge and connection were unrelated in our study population and depended on different determinants of nature experience.

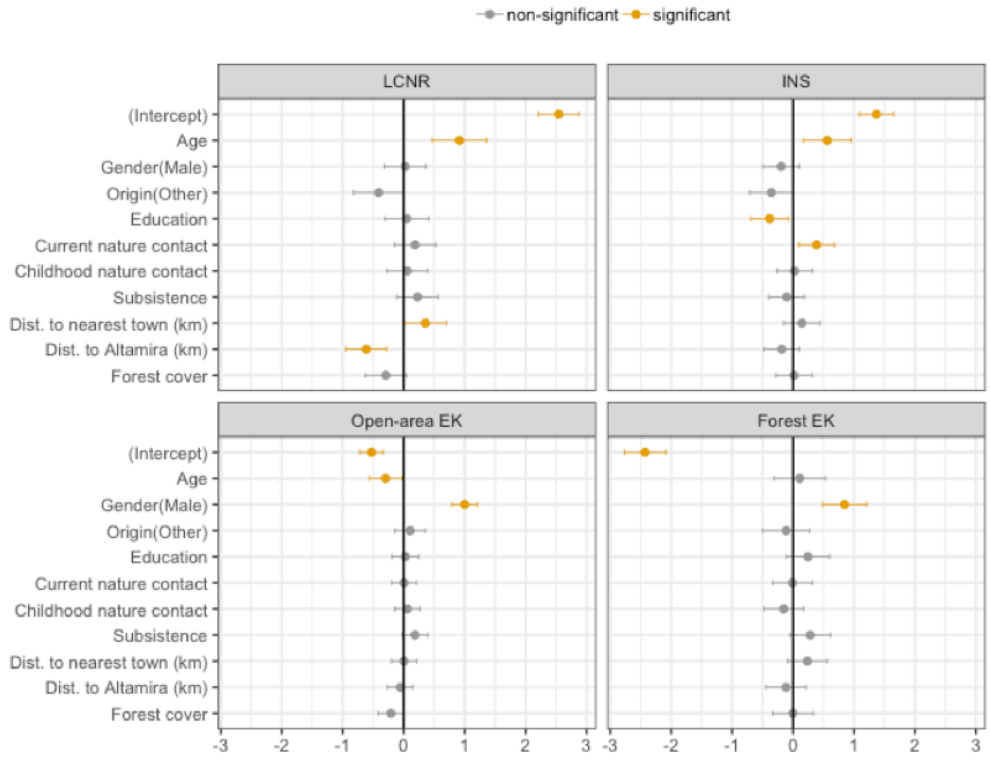

Figure 4.4. Generalised linear model results for CWN and ecological knowledge predictors.
Modelled effect sizes are presented with 95% confidence intervals. LCNR = Love and Care for Nature (affective nature connection), INS = Inclusion of Nature in Self (cognitive nature connection), Open-area EK = ecological knowledge of open-area bird species, Forest EK = ecological knowledge of forest-dwelling bird species.

Figure 4.5. The percentage of correct recognition of bird species separated by respondent's gender and bird habitat association.

4.6 DISCUSSION

Despite inconclusive empirical evidence (Hammond & Herron 2012; Cox & Gaston 2015; Lumber et al. 2017; White et al. 2018), there is a widespread implicit understanding among conservation biologists and the NGO community that a caring relationship with nature is strongly linked to ecological knowledge (EK). Using robust measures and a solid sampling design, we investigated the relationship between EK and connection with nature (CWN) in a population of colonist farmers at a major Amazonian deforestation frontier. These contexts are critical arenas in which habitats and biodiversity declines are co-occurring across the tropics (Barlow et al. 2016), yet have been hitherto largely overlooked by the growing literature in conservation psychology (Mastrangelo et al. 2014). Our main finding was that CWN and EK – as measured by bird identification skills – among the Transamazonian farmers were uncorrelated and associated with largely separate sets of predictors. Hence our study provides evidence against the existence of an inherent universal link between EK and caring for nature. In other words, higher levels of EK do not appear to translate into a greater "love for nature".

Our work also makes an important contribution towards the understanding of the levels and drivers of EK and CWN in maturing deforestation frontiers, by generating baseline information on the levels (EK) and predictors of CWN and EK among Transamazonian farmers. Importantly, knowledge of the forest-dwelling species was far below that of open-area bird species, which may signal that farmers are unaware of the rich forest biodiversity. This may be a cause for concern, given that people tend to place higher value on places which they perceive as more bio-diverse. Moreover, without identification skills declining populations of threatened forest species may well go undetected by local people, often regarded as being on the "front line" of conservation. This is significant in Amazonia because, in places where traditional forest peoples are absent, colonists are considered as key "conservationist actors" (Campos & Nepstad 2006). We also identified a surprising relationship showing that affective connection is closer to the region's main city. This raises the possibility that engagement with environmental institutions – concentrated in urban centres – might support strong CWN, suggesting an exciting new interdisciplinary direction for further research into human-nature relationship.

4.6.1 Ecological knowledge is not always related to caring for nature

Our main finding is that the positive relationship between EK and caring for nature, found previously in several UK-based studies (Cox & Gaston 2015; White et al. 2018), does not appear universal. Weak correlations and largely separate drivers of CWN and identification skills – a finding robust to our different measures of EK and CWN – provide strong evidence against the existence of an inherent link between ecological knowledge and caring for nature. Contrary to Baba Dioum's statement that caring for nature is contingent on nature understanding, many of the farmers we interviewed who felt highly connected to nature were able to identify only a few bird species (Figure 4.3.). Conversely, good species identification skills did not guarantee love and caring for nature, even though people with low CWN were a minority. The lack of an inherent link between EK and CWN evident in our study is supported by recent psychological research, which has started to characterise the very qualities of different nature experiences that can help people develop different aspects of a holistic, committed relationship with nature (Lumber et al. 2017; Giusti et al. 2018; Richardson & McEwan 2018). Indeed, knowledge-based activities feature there little, or not at all.

This finding from our study has two key implications. First, high EK should not be assumed to indicate high CWN. Therefore, separate dedicated measures should always be used to quantify these constructs in studies. Second, outreach strategies based on promoting factual ecological knowledge, though popular in environmental education campaigns (Stern et al. 2014), are unlikely to generate greater sense of care towards nature on their own. Where low CWN is specifically identified as a problem, environmental organizations probably should not rely solely on the dissemination of ecological information to address it, but rather develop strategies especially designed to promote pathways to CWN, including experiences of contact, beauty, emotions and compassion with nature (Lumber et al. 2017). However, it seems that in many rural contexts in the Global South people already feel strongly connected with nature and there may be little need for campaigns especially designed to strengthen this connection (Clayton et al. 2013). Moreover, though we did not detect any clear common drivers and our results suggest that CWN may not be dependent on EK, neither are these constructs antagonistic and it is possible that some interventions may increase CWN and EK simultaneously (Stern et al. 2014; Giusti et al. 2018).

4.6.2 How do people fall in love with nature?

Most existing studies on nature connection have been conducted in the Global North, primarily in urban settings, where potential erosion of experience of nature is a concern due to physical separation of people from natural settings. Our study provides important insights into what patterns of CWN may look like in a socio-environmental context where the anthropogenic transformation of natural areas is still relatively limited and opportunities for encounters with nature more common. In contrast to knowledge, connection was most related to socio-demographic factors and nature contact measures indicative of time spent in natural settings. However, the role of nature contact measures was not so obvious as in previous studies (e.g. Soga et al. 2016), with significant relationships apparent only with cognitive, but not affective CWN. This could be because the rural farm-forest landscapes around the Transamazon highway are sufficiently saturated with intentional and unintentional opportunities for nature experiences, such as frequent overflights of colourful parrots and macaws, to build and sustain a high sense of emotional connection among majority of the population, and visits to more natural settings may merely enhance it.

The effect of age was consistent across both measures of CWN. Age has been positively linked to CWN in other studies too (e.g. Luck et al. 2011), however, the exact mechanism relating age to CWN is hard to decipher without longitudinal data, since it could relate to myriad unmeasured factors. One of the possible explanations is place attachment - the cognitive and emotional bond between person and place (Baldwin et al. 2017). Although older respondents were more likely to be migrants themselves (not shown), they typically had also lived in Amazonia and on their property for longer than younger interviewees, which perhaps gave them the opportunity to develop stronger CWN through attachment to nature on their properties (Bogdon 2016). Alternatively, the positive relationship between age and CWN could be a generational effect. Levels of connection could also be influenced by cultural differences between different Brazilian states (Hoelle 2011). Although the influence of origin was short of significance threshold, it was very similar across both measures of CWN, hinting that the culture in Amazonia may be more conducive to connecting with nature than elsewhere in Brazil (Oestreicher et al. 2014). Overall, it appears that despite significant forest loss, large-scale socio-environmental transformation over nearly 50 years in this

part of Amazonia has not resulted in any clear "extinction of experience" and resultant loss of CWN, in the fashion recognisable in many Western areas (Miller 2005).

4.6.3 Levels and drivers of ecological knowledge in the Transamazon Highway region: poor recognition of forest species may be problematic

Differences in EK levels among the respondents followed patterns similar to those observed in another migrant population of farmers living near a protected area in southern Sumatra (Nyhus et al. 2003). There, younger people were more knowledgeable than older ones and men tended to be more knowledgeable about local mammal species than women. Accordingly, younger interviewees in our study held more knowledge of open-area bird species than older respondents and men recognised far more bird species than women. Since knowledge was unrelated to frequency of nature visits, this may suggest that "knowing about animals" is a part of gender role played by men in the Transamazonian society, probably through its relation to hunting, typically regarded as a male activity (Mmassy & Rskaft 2014; Oestreicher et al. 2014). Importantly, the respondents in our study also recognised the conspicuous open-area species much more frequently than the secretive forest-dwelling species, which are a lot harder to spot among dense foliage even for experienced birdwatchers. This last finding was also aligned with the Sumatran study (Nyhus et al. 2003) and may be a cause for concern.

Low identification skills may be a problem, because even though EK may not be critical to developing CWN, it may provide synergistic benefits through raising awareness of local species and value attributed to local ecosystems. For example, developing identification skills through exercises such as "Bio-blitzes" – communal, citizen-science events aimed at recording as many species at a single site as possible over a short space of time – can help people notice more species and increase their awareness of the biodiversity around them, helping to anchor an abstract sense of CWN in real nature (Pollock et al. 2015). Appreciating natural spaces around us as more biodiverse can in turn make us value them more and experience greater mental health benefits from them (Cracknell et al. 2016; Fischer et al. 2018), as these factors are associated with perceived rather than actual species richness (Dallimer et al. 2012). Moreover, where goodwill to protect species already exists, promoting more EK about a species can

incentivise its more effective conservation. This is illustrated by the case of a media campaign to reduce poaching pressure on saiga antelope in Russia (Howe et al. 2012).

In the Transamazonian context, low recognition of forest bird species is worrying, because it suggests local residents may underestimate the biodiversity of their forests and potentially value them lower than they would, had they been aware of higher species richness, although this needs testing. Moreover, poor knowledge of forest species limits the possibilities for using farmers information to monitor threatened forest taxa. Local EK is often used as an important knowledge source for biodiversity monitoring (e.g. Ochoa-Quintero et al. 2015; Parry & Peres 2015). However, our data suggests that only a small proportion of Transamazonian farmers could be considered "experts" who possess sufficient identification skills to reliably detect different species and potentially provide useful information on species presence and population changes (Davis & Wagner 2003).

Among our sample, most respondents reported some use of forest products, but it was rare for them to have a high direct livelihoods reliance on natural ecosystems (SI) and nature-reliance indicators, though showing some significant trends, did not appear as a significant pathway towards EK. This contrasts with Pilgrim et al (2007) who showed a strong relationship between EK loss and wealth, possibly because they used different measure of nature reliance (income and GDP) and focused their analysis on differences between communities and nations, as opposed to within-community variation. Average levels of species recognition and above-zero-but low reliance on forest subsistence products place Transamazonian farmers somewhere in the middle of Pilgrim et al.'s (2007) curve of the relationship between knowledge and wealth. This situation may be characteristic of agricultural deforestation frontiers in the tropics, though must be clearly different to many other rainforest societies, including indigenous and traditional people in the Amazon, where people live off a mixture of fishing, forest extractivism, and small-scale agriculture (Oestreicher et al. 2014).

4.6.4 Could nature connection be part of environmentality?

Our most unexpected finding was that rural farmers living farther away from Altamira felt less emotionally attached to nature than average. Urban remoteness was supposed to indicate "nature-reliance" and we had predicted it would correlate positively with EK

and possibly CWN, following (Pilgrim et al. 2008). One explanation for this finding may be found in the concept of "environmentality"; the relationship we identified might reflect the spatial gradient of engagements with "institutional regimes of environmental regulation" (Agrawal 2005). This is because environmentalist NGOs, agro-ecological extension services, academic researchers and environmental regulation bodies (e.g. Brazil's IBAMA) operate out of their nearest offices, most of which are located in Altamira – the largest and most cosmopolitan urban area in this part of the Amazon. In line with governmental policies of the era, at the beginning of modern colonisation period, migrant families were reportedly characterised by a "productivist" mind-set, seeking to generate revenue through the planting of conventional crops and seeing little value in the forest ecosystems on their properties (Moran 1977). However, since then environmental discourses have become more vocalized and – although inconsistently – internalized within governmental ministries and policies (de Toledo et al. 2017).

For example, a vocal local NGO, founded by social movements in the Transamazon and championing family-based agriculture, has promoted both environmental protection in the region, and a socio-ecological discourse emphasising the role that the local farmers, in contrast to large absentee landowners, can play as stewards and custodians of local forests and environment (Schwartzman et al. 2010). Repeated engagements with this and other institutions may have influenced the colonists' practices, knowledge, beliefs and feelings over time, including CWN. Of course, our evidence does not enable us to discount an alternative explanation, that farmers living closer to Altamira have simply better learned to adopt the rhetoric of sustainable coexistence with nature (Bratman 2011), without changing their true beliefs. However, stabilising deforestation frontiers is an urgent priority for biodiversity conservation and climate protection globally (Barlow et al. 2016), so this uncertainty merits further research.

4.6.5 Limitations and further directions

Our study has shed some light on the potential drivers of differences in ecological knowledge and nature connection among farmers around the Transamazon highway. However, while one off quantitative assessment such as ours are ideal to test large-scale spatial hypotheses, they also lack the depth of understanding that can be gained from qualitative approaches, and likely give an incomplete understanding of the drivers shaping CWN and EK in maturing deforestation frontiers. In particular, we emphasize

the need for greater attention to the role of social and cultural factors. We suggest it would be especially worthwhile to investigate the degree and form of any potential engagements with NGOs, government regulatory bodies, and agricultural extension services to test the hypothesis that the "institutional regimes of nature regulation" may be shaping the unexpected spatial differentiation which suggests that people living in more deforested areas closer to Altamira are more emotionally connected to and knowledgeable about nature than their peers. Combining psychological studies of nature connection with the concept of environmentality, stemming from anthropological research, could provide exciting new insights beyond iterative increases in disciplinary understandings of human-nature relationships, but is also sure to raise heated debates. This is because it would require forging a way to navigate the – somewhat incompatible – relativist anthropological assumptions and the positivist approaches underpinning most of psychological research. We also note that the Transamazon Highway is a maturing (though still active) frontier; research scope could be extended to include forest frontiers at different stages, particularly early-stage deforestation frontiers, which, though temporarily retaining highest forest cover, are typically characterised by very different socio-economic, cultural and potentially psycho-social conditions and motivations, as well as high deforestation rates (Schielein & Börner 2018)

4.7 CONCLUSIONS

Our results show that factual ecological knowledge may not be necessary to develop deep emotional connection with nature, particularly in rural places with plentiful opportunities for engaging experiences with nature. Where CWN is evidently low and a potential impediment to biodiversity conservation, a focus on frameworks specifically designed to enhance connection may be a priority. However, this and other studies demonstrate that CWN and pro-conservation value orientations are quite common in rural areas in the Global South and awareness raising campaigns can be effective tools in conservation. To the extent that the lack of ability to name even the most common species signifies the lack of awareness of their existence or presence around us, we have argued that low identification skills may be a cause for concern. Even for people having strong affection for nature and willingness to protect it, it would be hard to act to protect something whose existence one is unaware of. Therefore, we assert that a combination

of EK and CWN boosting activities would probably work best (Stern et al. 2014; Barthel et al. 2018). Baseline assessment of local EK and CWN levels could help design strategies most effective in leveraging conservation goals in a particular context. However, we should not forget that while willingness to protect is necessary, it is rarely sufficient – especially in landscapes where people have low incomes and limited opportunities to develop beyond agricultural expansion and intensification. Enabling institutions and regulations are required too, and people must feel capable of protecting the environment without damaging their ability to sustain their families.

Acknowledgments

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5 General Conclusions

General Conclusions

5.1 Background

An increasingly dominant perspective in conservation is that the contemporary biodiversity crisis is rooted primarily in unsustainable human behaviour and hence there is a critical need to integrate the human dimension into the "global conservation agenda" (Bennett et al. 2017). People's subjective psychological connections with nature (CWN) may be an important framework for understanding and improving humanity's relationship with nature, but this sub-field continues to be under-researched. As exemplified by a recent article in Science (Cinner 2018), this appears true even in the behavioural sciences. Related research is rapidly rising in popularity in conservation science and favours a narrow focus on the most effective ways of altering only some particular target behaviours, but gives less attention to the broader motivations for pro-environmental behaviour in general, such as CWN. Moreover, the little research that does exist on the importance of CWN for pro-environmental views and actions is severely restricted to countries in the Global North.

In this thesis I have sought to advance the understanding of CWN as an intrinsic pro-conservation motivation in the context of human-modified tropical landscapes. Specifically, I developed a new measure of affective CWN, adapted for use in rural areas with low literacy levels. The new scale was used it in combination with an existing scale measuring cognitive CWN, in order to measure CWN among colonist farmers living along the Transamazon Highway in South-eastern Brazilian Amazon, thus providing the first assessment of CWN in the rural tropics (Chapter 2). This assessment formed the basis to question entrenched beliefs about lack of intrinsic environmental concern in poorer societies in the Global South (Chapter 3), and scrutinize a related assumption that environmental knowledge is an effective pathway for increasing caring for nature (Chapter 4).

5.2 Contributions to knowledge

5.2.1 New tool shows that non-indigenous Amazonian farmers are highly connected to nature.

Understanding people's internal motivations to harm or protect nature is a an important, but under-researched topic in conservation science. In particular, it is important to understand the motivations influencing people whose decisions have direct impacts on biodiversity, such as farmers whose land-use decisions directly affect habitats available on their properties. Recent psychological studies suggest that differences in moral decision making with regards to nature protection are rooted in the strength of people connection with nature (CWN), i.e. in the subjective sense of interconnectedness with nature and emotional attachment to the natural world. However, so far CWN has been little studied among farmer and studies are lacking from the tropics, which harbour most of the Earth's biodiversity.

In Chapter 2, I present a new scale called Love and Care for Nature – Rural (LCNR) to measure affective CWN and validate it in a sample of Transamazonian farmers. This modified version of an earlier Love and Care for Nature scale (Perkins 2010) should facilitate incorporation of CWN into conservation studies, including those located in rural areas of conservation interest in the Global South. In particular, the new scale should enable researchers to examine how affective CWN relates to pro-conservation behaviours and to the effectiveness of conservation interventions. Similar to the majority of existing scales, the new scale I developed examines psychological CWN – by definition related to the extent of one's self-identification with nature – but remains linguistically rooted in the Western distinction between humans and nature. Thus, it is expected to perform best in those cultures whose languages make a similar distinction and has a clear limitation in not really moving beyond Western conceptualizations of nature. Nonetheless, using the LCNR and an independent measure of cognitive CWN, this study provides the first assessment of CWN in the rural tropics. The high levels of CWN detected suggest that CWN may be an important source of motivation to protect nature among non-indigenous, Transamazonian farmers in a colonization farm-forest frontier.

5.2.2 Intrinsic motivations matter for concern about nature in the rural tropics

Many conservationist institutions identify caring for nature as an important intrinsic motivation to help nature. However, a conventional wisdom – at times expressed in publications by powerful actors such as the World Bank – holds that poor people and poor societies are too preoccupied with their material needs to be concerned about nature beyond the material benefits that it provides to them. This discriminatory assumption is also implicitly expressed throughout the conservation "industry" (e.g. NGOS and consultancies) in the form of hegemonic interest in economic interventions dominating over research and potential interventions capitalising on internal motivations. This is also reflected in A lack of consideration for the impact of these interventions on subjective relationships with nature.

In Chapter 3, I question this dominant assumption that economic decision-making trumps other motivations. Using generalized linear models, I compare the effect of affective and cognitive CWN on pro-conservation attitudes relative to values, and economic, socio-demographic and geographical factors. The results suggest that pro-conservation views are widespread among non-indigenous Amazonian farmers and shaped primarily by affective CWN and values, but very little by economic factors. These findings imply that intrinsic motivations significantly contribute towards concern about nature regardless of economic standing, thus contradicting the entrenched belief that poor people are not intrinsically concerned about the wellbeing of nature. However, in accordance with wider frameworks of pro-environmental behaviour, qualitative comments reveal that the path from CWN to conservation action is long and that diverse factors – such as perceived economic constraints, lack of agency and differing perceptions regarding the sustainability of various management techniques – may prevent people with high CWN from behaving in a way that conforms to the conservationist agenda.

5.2.3 Ecological knowledge is not necessary to care about nature (but may still help)

Conservation literature is replete with writings implicitly or explicitly expressing the view that caring for nature is predicated on ecological knowledge. This assumption seems also to underpin many environmental education programmes, which overtly aim

to increase awareness and caring about the environment, yet often measure success based on the increase in factual knowledge about nature. Yet, like many such conventional wisdoms regarding motivations for conservation, the assumed positive link between ecological knowledge and caring for nature has rarely been tested and the existing evidence remains inconclusive. Here, I sought too question this assumption, since existing evidence is inconclusive, limited to countries in the Global North, and does not adequately examine drivers of ecological knowledge and connection with nature.

In Chapter 4, I investigate the relationship between ecological knowledge (EK), measured as the ability to identify common local bird species, and both affective and cognitive CWN among a farming community around the Transamazon Highway. The correlations detected are weak and non-significant, showing EK and CWN to be unrelated in our study population. Furthermore, an analysis based on generalised linear models demonstrates that EK and CWN associate with separate sets of predictors related to access to nature, direct economic reliance on nature, contact with nature and socio-demographic factors. One of the detected associations – that people living closer to the largest local urban centre (Altamira) have higher affective CWN than those living further away – is counter to my prediction. To interpret this surprising finding, I draw on the theorizing of governance, and Arun Agrawal's notion of environmentality in particular. Accordingly, I interpret my results as evidence that people living closer to the city may have higher CWN as a result of more frequent engagement with institutions such as environmental NGO and regulatory bodies. Additionally, the study reveals rather poor average knowledge of forest-dwelling species as opposed to the more conspicuous open-area species. I identify this low recognition of forest species as a potential concern, to the extent that it may signify the lack of awareness about the existence of these species and potential undervaluation of local forest biodiversity by the Transamazonian farmers. This is because even in the presence of high CWN and pro-conservation attitudes, people can only be expected to take conscious efforts to protect only those species that they know to exist and habitats which they consider to have high biological value.

5.3 Insights for conservation practitioners

The findings presented in this thesis have several important implications for conservation:

a) Subjective relationships with nature should be considered in the design of conservation interventions. The heterogeneity and baseline levels of internal motivations to protect nature in the target populations should be identified beforehand, both to assess the likely effectiveness of planned interventions and any potential unintended perverse outcomes. Quantitative measures of CWN can provide an efficient and reliable indication of intrinsic motivations for protection and should be applicable in many contexts, including in at least some rural areas in the Global South. Planners need to ensure that existing intrinsic motivations are not "crowded-out" and suppressed, e.g. by economic interventions inadvertently emphasising the utilitarian value of nature or by perceived injustice of environmental regulations and their application (Rode et al. 2015).

b) Intrinsic motivations to protect nature can be relatively high in the rural tropics, even at infamous farm-forest frontiers such as the Transamazon Highway. Consequently, these motivations should be acknowledged and taken seriously alongside utilitarian motivations in political discussions about the valuation of nature's contributions to people – a conclusion which strongly resonates with the holistic approach that the IPBES is currently trying to implement (Masood 2018).

c) Contrary to a common assumption, greater ecological knowledge is unlikely to encourage connection with nature on its own, and vice versa. This resonates with other studies which argue that a holistic relationship with nature is best achieved in authentic situations which combine ecological learning with active engagement in activities involving direct contact with nature and promoting emotion, compassion and/ or perception of beauty (Lumber et al. 2017; Barthel et al. 2018; Giusti et al. 2018).

d) In populations characterised by low CWN, strengthening this connection could offer a pathway to increase intrinsic motivation for a wide variety of behaviours that contribute to nature conservation, such as farmers' motivation to retain forest patches on their properties, or to tolerate both benign and potentially undesirable wildlife that lives on their land. However, this and other studies demonstrate that strong sense of CWN can be quite common among populations inhabiting priority areas for conservation. When intrinsic motivation for conservation is strong among a population and no substantial behavioural barriers are present campaigns could be an effective tool to promote behaviours protecting target species or habitats.

e) Even strong intrinsic motivations to protect nature may be in many cases necessary but often insufficient to produce pro-conservation behaviours on their own, because of real and perceived behavioural barriers. Enabling institutions – e.g. just, transparent and non-corrupt systems of environmental regulation, training in sustainable management techniques accompanied with affordable credit and tax regimes to implement them, etc. – are required in order to overcome behavioural barriers and ensure people are empowered to pursue their visions of living harmoniously with nature.

5.4 Limitations and Future Directions

5.4.1 Challenges of advancing behavioural motivation research in the context of tropical conservation

In this thesis I made a link between CWN and the conservation attitudes of the Transamazonian farmers (Chapter 3). The next obvious step would be to attempt to link CWN all the way up to actual conservation behaviours. However, this is challenging, because such behaviours, e.g. hunting or intentional forest burning, are not only difficult to observe and measure directly, but also often illegal under many circumstances, and therefore challenging to measure reliably at the individual level (Nuno & St. John 2014). Intuitive proxies for behavioural outcomes, such as objective measures of property level forest cover based on satellite images, can also be confounded with external influences, e.g. the legacy of land management decisions taken by previous property owners, or unintentional deforestation caused by escaped fires spreading from neighbouring

properties. For this reason, I opted against using them in the present research. One way to approach this problem could be to conduct a longer-term study, where CWN, attitudes, intention, behaviour and possible confounding factors would be assessed through interviews at several times throughout the study and behavioural outcomes would be independently monitored through satellite image data. However, such a design could still be fraught with difficulties in gaining the trust of non-compliant farmers and recruiting and retaining them in the study.

Another challenge to advance research on behavioural motivation in conservation is to study both "down" and "up", i.e. to study the motivations both of those actors who are less powerful and those who are more powerful than the researcher themselves (Nader 1969; Bowman 2010). For example, as I point out in Chapters 2-4, my work in this thesis largely excludes the perspectives of the largest landholders (owning > 650 ha). Whereas smallholders and medium landholders are generally easily approachable, the largest landholders often don't even live in the same state. During my fieldwork, I was too afraid to purposely seek out even those of them who do live along the Transamazon Highway and whose addresses I was given by their workers – too much interest in deforestation and land disputes in conflicts involving some of the most powerful landholders have cost lives. Among these were the infamous assassinations of Ademir Federicci "Dema" in Medicilândia in 2000 and Sister Dorothy Stang in Anapú in 2005, both of them local leaders fighting for social justice, environmental protection and against major cases of corruption. By inhibiting access to the most powerful, corruption and violence severely limit the potential scope of conservation research on behavioural motivation and behavioural change in many places, due to the disproportional impact of these actors on conservation outcomes. For example, large landholders control only ca. 3% of all properties in the Transamazon Highway region, but these properties account for over one third of the colonised land and nearly one third of deforestation in the region (Godar et al. 2012). These impacts are further amplified through political means, because the agroindustry and large cattle ranchers form a powerful lobby in the Brazilian politics (Moran 2011)

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5.4.2 Beyond personal connection: linking CWN to cultural and social perspectives on Human-Nature Relationships.

Psychological connection with nature is usually defined as the personal sense of oneness or separation from nature and the strength of the associated emotional attachment to nature. However, recent research indicates that a holistic personal relationship with nature is a more complex, embodied ability (Giusti et al. 2018). Abilities that we typically associate with CWN – caring for nature and being one with nature – form only one cluster of "being FOR nature" abilities. The other two clusters include "being IN nature", e.g. feeling comfortable in natural environments, being curious about nature, and "being WITH nature", e.g. knowing about nature, 'reading' natural spaces and acting in them, and feeling attached to natural spaces. Giusti's et al.'s research indicates that children learn these different abilities through a non-linear progression starting from "being IN nature", through "being WITH nature" to "being FOR nature" and different situations promote acquiring different types of abilities. The learning of "being FOR nature" or CWN-related abilities in particular requires repeated engagement in meaningful nature-related situations which are thought-provoking, involve mentors, are socially/culturally endorsed and guided with some structure and instruction. This perspective complicates the view of CWN as being promoted simply by contact with nature and highlights the importance of socialisation for the development of a deep personal relationship with nature. Such a view of CWN's development opens up a possibility to link it up to theories of societal relationships with nature, because whether humans as a group belong to nature or are separate from it is also a central question that each society must ask (Zimmerman 2004; Descola 2007).

According to the anthropologist Philippe Descola (2007), the answers that different cultures give to the question of belonging or separation from nature, reflect different ontologies of human-nature relationship. He argues that these vary broadly across two axes: the similarity/dissimilarity of humans and non-human nature in material body, and in the "interiority" (mind/soul/spiritual essence). For instance, 'Western' culture is predicated on the notion that what separates us humans from non-human nature are the attributes of our interiority: our mind, soul, subjectivity, morality, – and not our material bodies which show close biological similarities with other organisms. This ontology Descola calls "naturalism". By contrast, this view is inverted in "animism" – an

ontology whose numerous variations are characteristic of most indigenous peoples in the Americas, which claims an "identity of soul and a difference of bodies". That is, animic cultures are predicated on the belief that despite morphological differences, all organisms share a common essence: they do not deny personhood to other beings as the Western cultures do. Thus, certain cultures might be more conducive to feeling part of nature than others. What does it imply for personal CWN? Can cultural perspectives impose limits on how strong are our personal bonds with nature? If a Transamazonian farmer, with a view of nature influenced by Western dichotomies, says she feels very strongly a part of nature, how does her experience of this connection compare to that of a member of the Native American Diné people, who knows that all things in nature – including her, other people, animals, plants, mountains and stars – are connected in a great interwoven web of kinship relations through a common spiritual essence (Zimmerman 2004)? Does the cultural background influence how strongly CWN motivates pro-environmental action? I believe such questions could provide a direction for fascinating research, albeit one that would likely require more sophisticated methods than the crude and reductive CWN Likert-like scales can offer.

Similarly, Giusti et al. (2018) conceptualise the human-nature relationship as a complex and embodied activity, i.e. one developed and enacted through active participation in various nature-related activities and practices, rooted in real, physical natural spaces. This emphasis on embodied practice over mere contact with nature as the pathway to CWN allows us to draw a link to another anthropological theory – the theory of environmentality. The environmentality thesis proposes that engagement in "institutional practices of environmental regulation" – such as participation of local people in village forest councils sanctioned by the government, and in patrolling the local forest – may result in a fundamental change of people's views regarding the value of environmental protection and what constitutes appropriate relationship with nature (Agrawal 2005). Thus, which comes first – CWN and values or behaviour? – may be a bit of a chicken and egg situation. This opens up the exciting possibility that rather than trying to change people's deep seated values and CWN in order to change a large number of behaviours, conservation interventions could attempt to steer people towards some few particular pro-environmental behaviours which over time could result in the realignment of values and CWN. This realignment could in turn feed into the promotion of a wider range of pro-environmental behaviours, closing the cycle. Such an

acknowledgement of complex feedbacks between individuals, their motivations, behaviour and society necessitates the careful consideration of possible outcomes of planned interventions and acceptance of a certain degree of unpredictability of these outcomes (Clayton et al. 2017). This contrasts with the dominant approach present in literature on economic incentives for conservation and indeed in much of behavioural economics literature, which are often narrowly focused on behaviour as the only outcome of interest and may at times neglect potential unintended negative consequences of interventions, such as negative impacts to people's subjective wellbeing or crowding out of intrinsic motivations for conservation (Rode et al. 2015; Cinner 2018).

5.5 Conclusion

In a world with a rapidly growing human population and increasing demands on Earth's natural resources, conservation becomes an ever more difficult endeavour and no single "solution" is likely to solve the biodiversity crisis. Yet there can be little hope of saving nature if people don't want to save it. Let us pay more attention to connection with nature – the science of caring about the natural world – and integrate it into the conservation agenda to try to ensure that humanity never loses the motivation to seek the myriad pathways needed to reach a more harmonious coexistence with the rest of the biosphere.

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7 Appendices

7.1 Appendix 1 – Chapter 2 Supplemental methods

7.1.1 Study area history

Large-scale colonization of the Transamazon Highway region began in the 1972 with a government program forming agrarian settlements along the newly constructed highway. The proximate goal was turning the rainforest into farmland (see Moran 1981). Underlying reasons included geopolitical occupation of Amazonia by the military government and a strategy to resolve landlessness following agricultural mechanization in the South of Brazil, and extreme droughts in the Northeast (Bernady Santana 2009; Souza 2014). The government withdrew funding and support for the colonists in 1974, focusing instead on incentivising large-scale agribusiness. However, 'spontaneous' colonisation around the Highway continued without government financial assistance. Typical of forest frontiers, the colonist turnover was reportedly high, with new families arriving for many years after the opening of the Highway, either to settle new areas or replace out-going colonists (Fearnside 2001).

Today, the study area contains a diversity of landholdings from a few to thousands of hectares, although the landscape still broadly reflects the configuration of the original 100 ha settlement plots, known as lotes. Properties are arranged along parallel side-roads running perpendicular to the highway and distributed 5 km apart. Many of the properties are still 400 m wide and 2500 m deep, so that plots from the neighbouring side-roads share the rear border, forming the so-called "fish-bone" deforestation pattern observable from space.

7.1.2 Interview protocol

We prioritized interviewing the farm owner and his/her spouse, although if not available we sought to interview their immediate family, provided they were actively involved on the farm. Employees, occupiers and tenant-farmers were not interviewed because preliminary research showed that landowners are nearly always responsible for land-use decisions such as deforesting. If an interview was declined (n = 23) or no-one eligible was available for interview, we attempted to interview at the next closest property, and so on. On three occasions, farmers from neighbouring properties were interviewed opportunistically, during their visits to households that were already being interviewed. In these cases, the visitors were interviewed about their own properties,

which were later geo-located. Similarly, seven of the interviewed property owners did not live on the properties we enquired about. In those cases, although we travelled to their primary houses for interviews and geo-located those for the purpose of calculating forest cover in household neighbourhood, the questionnaires still applied to the properties near to the sampling points.

7.1.3 Origins of respondents

Those respondents from the North were exclusively from Tocantins and Pará states. Other respondents grew up in States from across Brazil, from the Northeast (73, in states of Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, Sergipe), Southeast (28, in Espírito Santo, Minas Gerais, Rio de Janeiro, São Paulo), South (25, in Paraná, Rio Grande do Sul, Santa Catarina), to the Central-West (9, in Goiás).

Table S. 7.1. Descriptive statistics for "Love and Care for Nature –Rural"

Item no	Mean	Trimmed mean	SD	Skew	Kurtosis	SE	Median	Min	Max
1	4.56	4.68	0.68	-1.68	3.42	0.04	5.00	1	5
2	4.35	4.65	1.21	-1.68	2.17	0.08	5.00	1	5
3	4.11	4.39	1.57	-1.36	-0.03	0.1	5.00	1	5
4	4.71	4.89	0.75	-3.31	11.76	0.05	5.00	1	5
5	4.79	4.94	0.6	-3.84	17.1	0.04	5.00	1	5
6	4.32	4.56	1.08	-1.67	1.91	0.07	5.00	1	5
7	4.87	5	0.57	-5.64	33.38	0.04	5.00	1	5
8	4.93	5	0.36	-7.12	62.3	0.02	5.00	1	5
9	4.7	4.96	0.9	-3.29	9.85	0.06	5.00	1	5

7.2 Appendix 2 – Chapter 2 Exemplar qualitative comments to the LCNR scale

Table S. 7.2. Exemplar qualitative comments illustrating respondents' connections and disconnections with nature.

	Connection	(relative) Disconnection
Connectedness: Nature as a source of life, as family, as community one belongs to	"Tree is life." "The forest is the heart of the world" "Everyone needs nature. There is no life without it. Nature calls us to herself." "My focus is nature, planting. It's nature that we come from, and nature where we go back to, it's a part of us" "I am part of the forest, I was raised in nature." "I am a daughter of nature."	"I like nature for recreation, but don't feel a connection" "One could be praised for saying they love nature, but I don't. I just like it." "I do not feel love for nature, I only use it to sustain myself." "I like [nature] but I am very easily scared." "I am very afraid of the forest, of snakes and animals."
Compassions towards nature	"An animal has got a life same way we do, even a plant breathes. In our forest we won't allow anyone to disturb the animals, no way!" "There is nothing more important than nature to me, I love it. I even had a quarrel with a traveller on the road, because I complained to him for killing a tamandua with no need. I don't kill nature's animals, only possums and snakes inside the property, but I don't like it at all." "I no longer even hunt for this reason [feeling sad seeing animals suffering unnecessarily] "I even give medicines to [wild] animals who catch diseases off the cattle." "I don't like to keep animals from nature. They're pretty, but they should stay out there, when caged their song is sad. "For example [what makes me sad] is when someone kills a monkey with pesticide. If we destroy the forest, what will the monkeys eat?!	"The forest is for giving shade and animals are for hunting." [in response to question about feeling sad seeing forest fires]: "Not so much, since we see forest everyday here." "There's so much peccary here, if I could I'd kill them all."
	Connection	(relative) Disconnection

Self-restoration in nature	*[In nature] “I even feel at peace” “I love nature. Even the air in the forest is different.” “The sensation of hearing a bird sing in the forest is lovely.” “I used to have depression. I cured myself at the river.” “I like to [go to nature] to disconnect from the world.”	“I don't go [to nature to feel better], because I don't it visit it much and don't know it well.” “[I don't go to nature to feel better], I like to be in the middle of people. I won't isolate myself.”
Awe and emotions in nature	“Everything is joyful there [in the forest]!” “The smell of the flowers! The green of the forest is life!”	

7.3 Appendix 3 – Chapter 3 Supplemental methods, modelling and analysis

7.3.1 Values analysis

The PVQ21 items were first ipsitized by subtracting the personal mean from all scores. Universalism and Traditionalism value variables were calculated using weights from fixed equations provided by M. Strack (pers. comm 2018), derived through the exploratory factor analysis method by Strack and Dobewall (2012) applied to PVQ21 data from all five waves of European Social Survey.

Table S. 7.3. Fixed equations weights for calculation of Universalism and Traditionalism variables

PVQ 21	Universalism	Traditionalism
Constant	-0.980	-0.236
V1. creativity	0.056	-0.136
V2. richness	-0.175	0.027
V3. equality	0.176	-0.027
V4. showing skills	-0.163	0.014
V5. safety	-0.029	0.155
V6. different experiences	0.021	-0.149
V7. following rules	-0.049	0.138
V8. understanding others	0.211	-0.066
V9. modesty	0.104	0.060
V10. pleasure	0.000	-0.140
V11. freedom	0.083	-0.119
V12. helping others	0.218	-0.042
V13. success	-0.182	0.016
V14. strong government	-0.015	0.152
V15. adventures	-0.049	-0.115
V16. behaving properly	0.010	0.158
V17. respect from others	-0.158	0.122
V18. loyalty	0.233	-0.050
V19. protecting nature	0.176	0.019
V20. tradition	-0.011	0.136
V21. fun	-0.006	-0.136

7.3.2 CWN – value relationship

Table S. 7.4 Spearman correlations between nature connection and value measures.
Nature connection measures: INS = Inclusion of nature in self, LCNR = Love and Care for Nature. The first four value rows represent PVQ-21 divided into the standard four dimensions, the last two represent same data reduced to two dimensions only.

Value	INS (P value)	LCNR (P value)
Self-transcendence	-0.04 (0.50)	-0.10 (0.11)
Self-enhancement	0.02 (0.80)	0.09 (0.18)
Conservatism	0.00 (0.98)	0.04 (0.51)
Openness	-0.01 (0.92)	-0.02 (0.71)
Universalism	-0.06 (0.39)	-0.11 (0.09)
Traditionalism	0.01 (0.91)	0.02 (0.72)

7.3.3 Forest cover

Forest cover was measured, at 4 different scales: 500m, 1000m, 1500m, and 2000m buffer around the household, using the raster package in R (Hijmans 2016). The different scales were compared via Akaike information criterion in single-predictor models. Four each attitude, only the FC scale with least AICc was included in subsequent model averaging approach.

Table S. 7.5. Forest Cover effects at different scales on attitudes: model comparison using AICc

Attitude	FC 500m	FC 1000m	FC 1500m	FC 2000m
Att1.Development over nature	663.2	663.1	663.1	663.1
Att2.Prevent extinctions	354.2	355.5	355.4	355.4
Att3. Protect forests	496.7	497	497.2	497.2
Att4.Control wildlife	527.6	528.6	528.5	528.5
Tapir tolerance	529.4	529.9	529.8	529.8
Macaw tolerance	392.8	392.1	392	393.1
Jaguar tolerance	715	713.4	712.8	713.7
Tree snake tolerance	701.4	699.3	698.8	698.6
Viper tolerance	619.1	619.8	620.1	619.7

7.3.4 Data missingness and imputation

Missingness for most variables did not exceed 1.2%, except for remoteness and forest cover (2%), and total monthly income (25%). Missing data were imputed only for

income and values. Income was recorded separately for each economic activity reported by the household. All income-generating activities were classified as either agriculture (21% missing), cash transfers (9% missing) including government support, retirement, and government salaries, and "other" (11% missing). Missing data occurred when an activity was reported but not valuated. Total income was the sum of income from the categories. Income was imputed using medians for individual income categories. Missing data for basic human values were imputed using series mean to enable the calculation of Universalism and Traditionalism variables. Missing data imputations did not affect the results.

7.3.5 Attitude modelling

Numeric predictor variables were standardised and rescaled to +/- 1SD around 0 mean prior to attitude modelling, binary variables were centred only (Gelman 2008). Global models were fitted using complete cases datasets for each attitude, and dredged. Models with delta<4 (based on AICc) were averaged. Effects not contained within averaged model subset were considered implausible for that attitude. Mean effects and confidence interval estimates for all plausible effects were based on conditional average.

7.4 Appendix 4 – Chapter 3 Values questionnaire PVQ-21

Table S. 7.6 Portrait Values Questionnaire – 21 based on the European Social Survey

No	Item	Subscale
1	Thinking up new ideas and being creative is important to him/her. He/ he likes to do things in his/her own original way.	Self-Direction
2	It is important to him/her to be rich. He/she wants to have a lot of money and expensive things.	Power
3	He/she thinks it is important that every person in the world should be treated equally. He/she believes everyone should have equal opportunities in life.	Universalism
4	It's important to him/her to show his/her abilities. He/she wants people to admire what he / she does.	Achievement
5	It is important to him/her to live in secure surroundings. He she avoids anything that might endanger his/her safety.	Security
6	He/she likes surprises and is always looking for new things to do. He/she thinks it is important to do lots of different things in life.	Stimulation
7	He/she thinks that people should do what they're told. He / she thinks should follow at all times, even when no-one is watching.	Conformity
8th	It is important to him/her to listen to people who are different from him/her. Even when he/she disagrees with them, he/she wants to understand them.	Universalism
9	It is important to him/her to humble and modest. He/she tries to draw attention to himself/herself.	Tradition
10	Having a good time is important to him/her. He/she likes to "treat" himself/herself.	Hedonism
11	It is important to him/her to make his/her own. He/she likes to be free and not depend 11on others.	Self-Direction
12	It's very important to him/her to help the people around him/her. He/she wants to care for their well-being.	Benevolence
13	Being very successful is important to him/her. He/she hopes people will recognize his/her achievements.	Achievement
14	It is important to him/her that the government ensures his/her safety against all threats. He/ she wants the state to be strong so it can defend its citizens.	Security
15	He/she looks for adventures and likes to take risks. He/she wants to have an exciting life.	Stimulation
16	It is important to him/her always to behave properly. He/she wants to avoid doing anything.	Conformity
17	It is important to him/her to get respect from others. He/she wants people to do what he/she says.	Power
18	It is important to him/her to be loyal to his/her friends. He/she wants to devote himself/herself to people close to him/her.	Benevolence
19	He/she believes that people should care for nature. Looking after the environment is important to him/her.	Universalism
20	Tradition is important to him/her. He/she tries to follow the customs handed down by his / her religion or his/her family.	Tradition
21	He/she seeks every chance he/she can to have fun. It is important to him/her to do things that give him/her pleasure.	Hedonism

7.5 Appendix 4 – Chapter 4 Exemplar statements illustrating respondents' beliefs about nature protection in the Transamazon Highway region.

Table S. 7.7 Examples of different beliefs influencing farmers' behaviours that harm or protect nature in the Transamazon Highway area.

Perceived injustice and lessened sense of obligation to protect
[respondent who intentionally deforested entire property] "With assistance of the government I would have left 50%. I agree with the law prohibiting deforestation, but without incentives or financing there is no way. If everybody protected and they would help, it could be 50%. If the fine arrives, I'll figure something out. The law is right, but assistance is needed. If you plant corn or rice you won't sell them. Each time you have to pick up a fiscal note and that's wrong. The government pays for agricultural technicians to do soil analysis, but they don't come here if you don't pay them more. Every time you want to put on fertiliser or plough the land there has to be a technician to make an analysis of the terrain, you have to pay. If you deforest there isn't this expense anymore, because [catlle] sells well." "Amazonia is not obliged to pay the price for other places that are already deforested. Sometimes there's a property that's not deforested at all yet, people should be allowed to work on it. The forest has to be preserved, but not all of it." "If the government created conditions to work on "terra mechanizada" (land improved with agricultural machines), the law could demand the protection of 80% [of the forest]. But it should be required that those who deforested must reforest, including those buying land that's already deforested. Because if not, it's not fair, it negatively affects some [those who didn't deforest much] and benefits others." "The law applies only to the smallholders, the rich do what they want. What makes me furious about this [forest preservation] law is that it doesn't serve the smallholders fairly. If it did, we could fine to protect 50% [of forest on each property]." "That who destroys the forest is the "fazendeiro" [large cattle rancher], not the smallholder"
Regret about deforestation
"Firstly, for us to survive here there's no need to devastate so much as has been done here, without control" "Nature must be protected, I regret having deforested so much in the past"

"Pará already developed what there was to develop. The development ended with Pará. The forest will only return if the government removes people from here, buying up land from the smallholders. I would gladly sell my land to preserve [forest] with much pleasure.
Perceived tensions between agriculturalist way of life and preservation – or lack thereof
"50% is enough for one to live on and for the forest to stay in place." "If people take care of the land that's already deforested [on their property], there's no need to keep on deforesting" "In this area development means planting crops. There is no way to protect everything" „The desire is to protect, but one has to deforest some too [to survive]."
Lack of agency to protect
"The government could help and purchase machines for us, or else let people burn on land that's already been deforested [to restore fertility]." "Brazil is very backwards. The system in Germany, France – they manage to survive on 20% [and 80% of property with forest standing]. But here no, because technical assistance [from the government], with better technologies we could preserve more" "Our life depends on nature, but of nature alone we cannot survive" "You can't live of nature, you cannot preserve as much as you'd like to"
Lack of agency to protect – specifically among women respondents
"If it depended on me, I wouldn't burn the forest, it's the greatest sorrow for me" "Seeing forests burn makes me very sad. If I could do something to stop the fires, I would". "If it depended on me, I wouldn't deforest so much nor kill animals. I always say to the man, but man is a critter with a strong nature."
Beliefs about sustainability of selective logging
"Logging ends up destroying lots. On the one side we fight to protect, and on the other the loggers destroy. Besides, the majority of trees they remove have fruits that animals feed on and the animals end up disappearing. " "Not even selective logging is OK. The money doesn't compensate the damage it does to the forest"

"It's no good to remove trees. Forest is important, needs to stay virgin" "Logging doesn't harm the forest at all. If you remove one tree, thousands of new ones are born in its place" "Even with management, they use it to remove lots of other [illegal] wood. IBAMA is "bought", the law doesn't function." "Managed logging is OK: remove one tree and plant another. If not, the wood goes to waste."
Link between deforestation and climate change
"We have to preserve [the forest], if not, it will become the Northeast [heavily deforested region in Brazil affected by droughts and desertification]." "The suffering today due to drought is because the forest is gone" "Because of climate change, last year there were many problems, cattle dying, rivers dried out. Everybody said that it's because of deforestation, it reached the limit." "I am outraged about everything that happens here with nature. Now we see that water starts to run out, it starts to get hotter, [I] start to worry that we have already passed the limits of deforestation."

7.6 Appendix 5 – Chapter 4 Supplemental methods

7.6.1 Forest cover calculation

Forest cover was calculated based on Global Forest Change raster maps 2015 v1.3, for granule 0-10S, 50-60W (available from: http://earthenginepartners.appspot.com/science-2013-global-forest/download_v1.3.html). The rasters included a baselayer from the year 2000 where each cell denotes tree canopy cover, defined as canopy closure for all vegetation taller than 5m in height and expressed as percent forest cover within output grid cell; a "gain" map highlighting areas that experienced forest gain since 2000 and encoded as either 1 (gain) or 0 (no gain), a "loss" map with areas that experienced deforestation since 2000 and encoded as either 1 (loss) or 0 (no loss), and a mask representing areas of no data (0), mapped land surface (1), and permanent water bodies (2). The baselayer from 2000 was reclassified such that cells with >50% forest cover were classified as forested (1) and those with <50% forest cover as non-forested (0). To create the land use classification for 2015, areas that experienced cumulative forest gain (based on the 'gain' layer) were reclassified as forested (1) and those that experienced forest loss as non-forested (0). Lastly, the mask layer was applied to exclude no data cells and permanent water bodies from analysis. Maps were reprojected to Sirgas 2000 Brazil Mercator projection. Based on this final classification, forest cover for each household was calculated as the percent of forested cells within 500m buffer. All this analysis was done in R using the raster package (Hijamns 2018).

7.6.2 Comparison of different methods of measuring ecological knowledge.

We compared four different methods of measuring ecological knowledge (Figure S. 7.1).

- Image – naming species from photograph (n = 19)
- Sound – naming species from sound recording (subset n = 8)
- Image-sound match – matching species sound to photograph (same subset n = 8)
- Combined scores – summing scores from the previous 3 methods

Correlations between the different methods were lower for forest-dwelling species than for open-area species, but the 'combined scores' method correlated highly with all three

remaining methods. Results shown only for datasets with bird names scores at genus level. Very similar results were obtained for names scored at species level or using 'taxonomic weights' (see below) and correctness at species level.

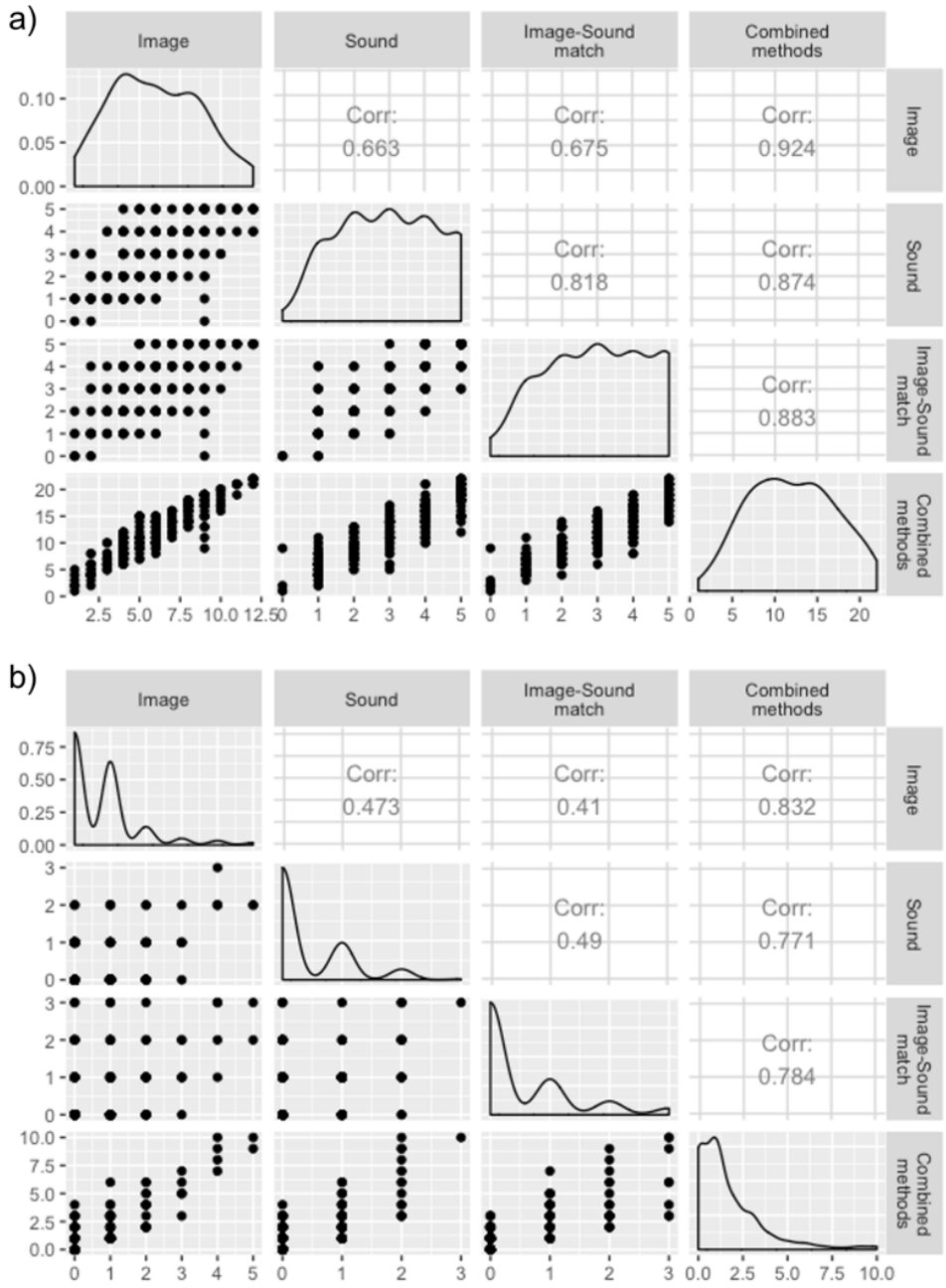

Figure S. 7.1. Correlations between different methods of measuring ecological knowledge based on recognition of bird species. a) open-area species b) forest-dwelling species.

7.6.3 Comparison of different ways of scoring correctness of bird species names.

We compared three alternative ways of scoring crestedness of bird species names (Figure S. 7.2)

- Taxonomic weights: 3 points were assigned for each bird species recognised correctly to species level, 2 points for each bird recognised correctly to genus level, 1 point for each bird recognised correctly to family level, 0 otherwise.
- Species level: for each bird species a score of 1 was assigned if it was recognised correctly to species level, score of 0 otherwise.
- Genus level: for each bird species a score of 1 was assigned if it was recognised correctly to genus level, score of 0 otherwise.

All three methods were highly correlated (Figure S. 7.1). Results shown only for dataset using combined EK measuring methods (see section above). Very similar patterns (all correlations > .95) were obtained when methods were compared by habitat and by different measures of ecological knowledge (results not shown).

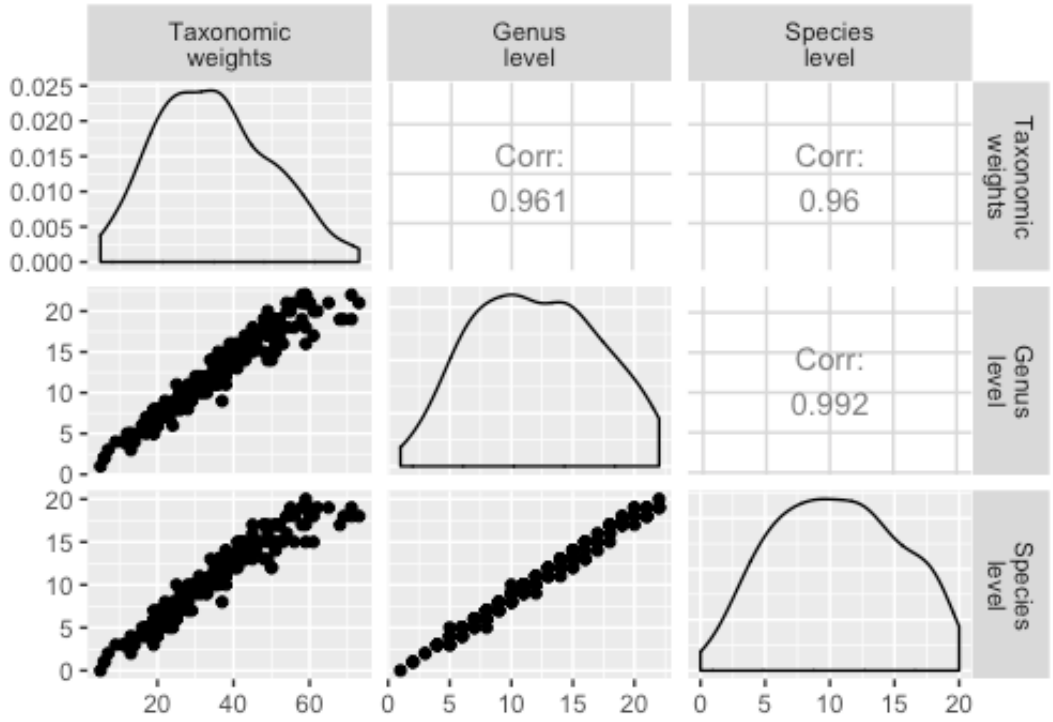

Figure S. 7.2. Correlations between different ways of scoring bird species names, using all 19 species and combined ecological knowledge measuring methods

7.6.4 Forest Subsistence Index distribution

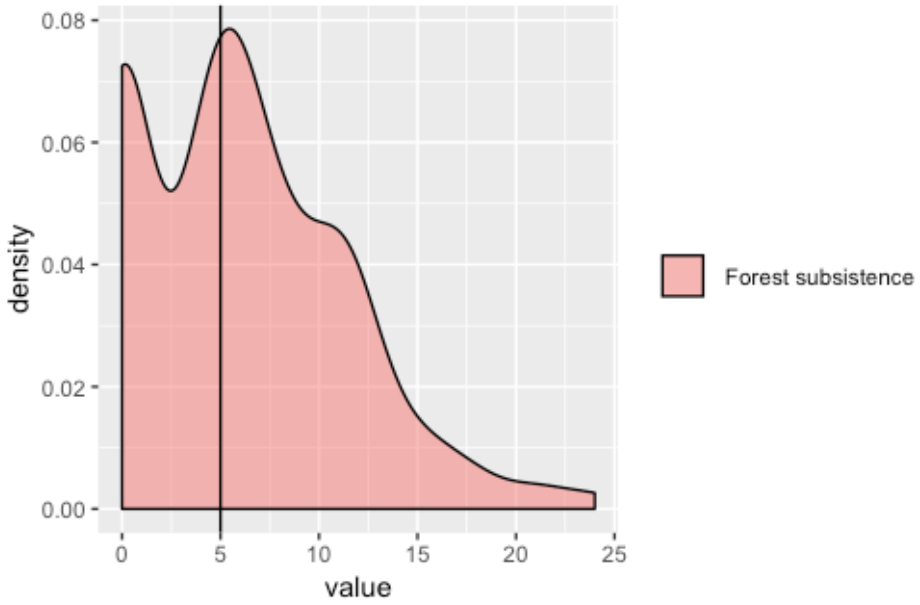

Figure S. 7.3. Forest Subsistence index distribution. Horizontal line denotes the median value.

7.7 Appendix 6 – Chapter 4 Characteristics of the bird species included in the measures of ecological knowledge.

Table S. 7.8 Characteristics of the bird species included in the measures of ecological knowledge.

Scientific name	Common name	Species characteristics
Coragyps atratus	Urubu-de-cabeça-preta	A ubiquitous species close to human habitation in both towns and rural areas throughout Brazil, readily recognisable by sight but usually silent.
Passer domesticus	Pardal	A ubiquitous species in urban areas throughout Brazil but rare/absent in rural areas, likely readily recognisable by sight and sound
Pitangus sulphuratus	Bem-te-vi	A ubiquitous species close to human habitation in both towns and rural areas throughout Brazil, readily recognisable by sight and its onomatopoeic call.
Columbina passerina	Rolinha-cinzenta	A common species associated with agricultural areas in Northern Brazil which often occurs together with Ruddy Ground-dove (Columbina talpacoti) and which is readily separable by plumage characteristics and call but which differences are easily overlooked.
Troglodytes musculus	Corruíra	A common but often unobtrusive bird species of rural and suburban areas throughout Brazil which is typically noisy but can be difficult to see.
Crotophaga ani	Anu-preto	A ubiquitous species close to human habitation in both towns and rural areas throughout Brazil, readily recognisable by sight and its onomatopoeic call.
Volatinia jacarina	Tiziu	A common species associated with pastures and cropland throughout Brazil which is also frequently kept (illegally) as a cagebird
Sporophila angolensis	Curió	An uncommon species associated with pastures and cropland throughout Brazil which is one of the most sought after cagebirds in the country and illegal harvesting has massively depleted wild populations. Easily recognised by sight and sound.
Sturnella militaris	Polícia-inglesa	A common species associated with pastures and cropland in Amazonia, its easily identified and has a fairly distinctive song. It is replaced outside of Amazonia by a sister species White-browed Blackbird (Sturnella superciliaris) which is very similar ecologically and morphologically but has a bold white eye stripe.
Vanellus chilensis	Quero-quero	A common bird species of rural and even urban/suburban areas throughout Brazil which is typically noisy (onomatopoeic name) and very easy to see and identify.
Caracara plancus	Caracará	An uncommon but very 'visible' bird of prey species of rural and even urban/suburban areas throughout Brazil which is very easy to see and identify. Persecuted in some areas due to depredation on small livestock.
Opisthocomus hoazin	Cigana	A charismatic, unmistakable and noisy inhabitant of flooded varzea forests in Amazonia which is unlikely to be encountered outside these areas
Eurypyga helias	Pavãozinho	A rather shy but no less charismatic inhabitant of riparian fringes which is rarely encountered outside of forested landscapes.
Cyanoloxia rothschildii	Azulão	A shy inhabitant of the understorey of Amazonian terra firme forests which would be difficult to observe without binoculars but has a distinctive beautiful song.
Odontophorus gujanensis	Uru	A shy terrestrial Amazonian species which is at least occasionally targeted by hunters for food. Easy to identify if seen well. It has a distinctive far-carrying song.
Cyphorhinus arada	Uirapuru	A very shy understorey Amazonian species which is similar to several other brown species with which it co-occurs but with an iconic and culturally celebrated song very different from any

		sympatric species.
Lipaugus vociferans	Cricrió	A rather shy largely Amazonian but incredibly loud species which occurs in exploded leks in terra firme forests. Occupying the midstorey it is shy and difficult to observe but audible for km.
Pionus menstruus	Maitaca-de-cabeça-azul	A common and easily-recognised parrot species with a wide distribution in Brazil and is usually associated with forest landscapes but may visit non-forest areas
Pseudastur albicollis	Gavião branco	An uncommon Amazonian hawk which is however often quite visible hunting alongside forest roads and is relatively easy to identify.