

The Hogg Eco-Anxiety Scale: Development and Validation of a Multidimensional Scale

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Abstract

Anxiety relating to a multitude of ecological crises, or eco-anxiety, is a subject of growing research significance. We used a multi-study mixed-methods design to explore eco-anxiety in Australia and New Zealand, validating a new eco-anxiety scale. In Study One, we developed and tested a 7-item eco-anxiety scale ($n = 334$), finding that this captured some, but not all, experiences of eco-anxiety. We found that people were anxious about a range of environmental conditions and their personal negative impact on the planet. Notably, people's anxiety about different environmental conditions (e.g., climate change, environmental degradation, pollution) were interconnected, lending support for the existence of eco-anxiety (a broader construct that encompasses climate change anxiety). These results informed further scale development in Study Two. Exploratory ($n = 365$) and Confirmatory Factor Analysis ($n = 370$) supported a final 13-item scale that captured four dimensions of eco-anxiety: *affective symptoms*, *rumination*, *behavioural symptoms*, and *anxiety about one's negative impact on the planet*, which were each distinct from stress, anxiety and depression. A further longitudinal sample ($n = 189$) established the stability of these factors across time. Findings support eco-anxiety as a quantifiable psychological experience, reliably measured using our 13-item eco-anxiety scale, and differentiated from mental health outcomes.

Keywords: eco-anxiety, eco-anxiety scale, climate change anxiety, anxiety, climate change, wellbeing

The Hogg Eco-Anxiety Scale: Development and Validation of a Multidimensional Scale

1.0 Introduction

The global environmental crisis is one of the most pressing public health issues of the 21st Century (IPCC, 2018; WHO, 2018). The mental health impacts related to the environmental crisis are diverse, ranging from loss, distress and grief, to emotional and behavioural problems and psychopathology (Clayton et al., 2017; WHO, 2020). Feeling anxious about the state of the planet appears to be universal, with evidence emerging from Europe (Haaland, 2019), America (Leiserowitz et al., 2018), Canada (Durkalec et al., 2015), Pacific Islands (Gibson et al., 2019) and China (Hao and Song, 2020). In New Zealand, one in three people are worried about climate change and 50% are *very* or *extremely* concerned about the impacts of waste (Ministry for the Environment, 2018). In Australia, 79% of adults are concerned about the destruction of native wildlife (The Australia Institute, 2020), and 59% of young people believe climate change is a significant threat to their safety (UNICEF Australia, 2019).

“Eco-anxiety” is a term that captures experiences of anxiety relating to environmental crises (Hickman, 2020; Pihkala, 2020). It encompasses “climate change anxiety” (anxiety specifically related to anthropogenic climate change, including global warming, rising sea levels and increased incidence of natural disasters and extreme weather events) (Clayton, 2020; Clayton and Karazsia, 2020; Pihkala, 2020), as well as anxiety about a multiplicity of environmental calamities, which may or may not be directly caused by climate change, including the elimination of entire ecosystems and plant and animal species, global mass pollution and deforestation. Given the interconnectedness between environmental issues in our global ecosystem, and evidence that people report anxiety over other kinds of environmental problems (Haaland, 2019; Helm et al., 2018; Hickman, 2020; Kelly, 2017), it is unclear whether climate change anxiety is distinct from other kinds of environmental anxiety. Furthermore, despite its growing research significance, there is still limited understanding of what the psychological experience of eco-anxiety entails.

The few existing measures for eco-anxiety and climate change anxiety capture the negative emotions (e.g., anxiety, worry) people experience when thinking about climate change and/or other environmental problems (Helferich et al., 2020; Helm et al., 2018; Kelly, 2017; Materia, 2016; Searle and Gow, 2010). This focus purely on affective symptoms ignores other potentially important characteristics of eco-anxiety. For example, there is evidence that eco-

anxious people experience cognitive and physical/behavioural impairments, evidenced by panic attacks, obsessive thinking, loss of appetite, and insomnia (Castelloe, 2018; Dockett, 2019; Hickman, 2020; Nobel, 2007).

Clayton and Karazsia's (2020) empirical investigation recently provided the first exception to this narrow focus on affective symptoms, demonstrating support for the multidimensionality of climate change anxiety. They identified cognitive-emotional impairment (e.g., rumination), functional impairment (e.g., interference with work and/or study capacity), pro-environmental behaviour (PEB), and experience of climate change as four unique dimensions in their scale, with the first two subscales constituting the "true climate change anxiety response" (Clayton and Karazsia, 2020, p.16). Their findings on the cognitive-emotional and functional impairments of climate change anxiety are compelling, particularly as they are consistent with research on (sub)clinical forms of anxiety (e.g., Generalised Anxiety Disorder) (APA, 2013). Noting the important contributions Clayton and Karazsia's research makes to the climate change anxiety and eco-anxiety literature, we sought to expand on the evidence for eco-anxiety using a mixed-methods approach to develop a comprehensive measure of eco-anxiety.

Clayton and Karazsia (2020) concluded rumination was an important aspect of climate change anxiety, using items that capture a person's critical evaluation of their distress in relation to climate change and of their reaction to the distress (example item: "I think "why can't I handle climate change better)"). We build on this by exploring a novel form of eco-anxiety-driven rumination, involving an active process of thinking repetitively about environmental degradation and climate change, which in turn fuels greater eco-anxiety (and hence, further rumination) (Rusting and Nolen-Hoeksema, 1998). This is supported by research showing that emotion-driven rumination is more strongly associated with anxiety symptoms compared to other sub-types of rumination (i.e., reflective and brooding rumination) (Olatunji et al., 2013).

Thus, while the literature on eco-anxiety is sparse, this is an important and developing area of research. To contribute to this field, we explored participants' experiences and symptoms of eco-anxiety in Study One, and used these findings to inform the development of a multidimensional measure of eco-anxiety in Study Two. We examined mental health and wellbeing correlates of eco-anxiety, including satisfaction with life, and whether eco-anxiety, as distinct from climate change anxiety or general anxiety, demonstrated good construct validity. By developing a multidimensional scale for eco-anxiety, we hope to facilitate important research on

the role eco-anxiety plays in the uptake of personal and collective PEBs; and whether specific dimensions and intensities of eco-anxiety are optimal for both the individual (i.e., mental health outcomes) and the planet (i.e., individual and collective climate action). Furthermore, while we acknowledge the importance of understanding eco-anxiety from a clinical perspective (and indeed we make comparisons between mental health outcomes and eco-anxiety in our research), we argue that eco-anxiety is a rational reaction to the enormity of the ecological threat humanity and the planet is facing.

2.0 Study One

We used a mixed-methods approach to gain insight into participants' experiences of eco-anxiety. Informed by the existing literature described above (e.g., Edwards, 2008; Helm et al., 2018; Searle and Gow, 2010), we included an initial 7-item scale to capture negative affective symptoms related to eco-anxiety. As the reported symptomatology of eco-anxiety appears remarkably similar to symptoms of Generalised Anxiety Disorder (GAD), this initial measure was modeled on the GAD scale (Spitzer et al., 2006), one of the most widely used psychological assessment tools that assesses the frequency of affective symptoms of anxiety. We modified this measure to capture the extent to which participants experienced each symptom when thinking about environmental problems.

To gain insight into the dimensionality of eco-anxiety, we conducted exploratory research on the focus of people's eco-anxiety, including categories of environmental degradation and personal behaviours that negatively impact the planet. As the opening paragraphs of this paper highlighted, there are a variety of different ecological crises happening in the world today and we sought to capture that in our investigation of people's experience of eco-anxiety. In addition, recent research suggests people feel guilty over behaviours that have negative environmental effects (e.g., flying via airplane) (Bamberg and Möser, 2007; Mkono, 2020). To understand whether this anxiety focused on one's own environmental footprint contributes to the experience of affective symptoms of eco-anxiety, we explored whether personal impact anxiety contributes to eco-anxious symptoms while controlling for anxiety about environmental problems. We also asked participants open-ended questions about how eco-anxiety impacts their daily functioning to gain richer insight into experiences of the phenomenon. We expected that eco-anxiety would be experienced beyond affective symptoms; interfering with psychological, physical and social functioning.

Finally, overlap between GAD and eco-anxiety has left some researchers questioning whether eco-anxiety is a unique construct (e.g., Helm et al., 2018). To address this concern, we examined how affective symptoms of eco-anxiety related to GAD, expecting a positive correlation below commonly accepted levels for multicollinearity, indicative of distinct but related constructs. We also examined the relationships between affective symptoms of eco-anxiety and life satisfaction and climate change belief, and expected eco-anxiety to correlate negatively to life satisfaction but positively with climate change belief. We interpret the strength of all correlations using Cohen's (1988) guidelines.

2.1 Method

2.2 Participants and procedure

Participants were 334 undergraduate students at the University of Canberra, Australia, aged between 17 and 65 years ($M = 22.23$, $SD = 6.65$) who completed an online questionnaire in exchange for course credit. Based on their age and gender distribution (135 males, 197 females, 1 'other', 1 missing), the sample was representative of most Australian university students (The Department of Education, 2019). Our minimum sample size of 196 was determined a priori to ensure the minimum sample size for Exploratory Factor Analysis (EFA) (Comrey and Lee, 1992) and Multiple Linear Regression (power analysis assuming a small to medium effect size of .05 - .10, alpha of .05, power of .80 and two predictors) was met. This research project received ethical approval from the Human Research Ethics Committee (No. 4483).

2.3 Measures

Affective symptoms of eco-anxiety were measured using an initial 7-item eco-anxiety scale based on the GAD-7 (Spitzer et al., 2006). Participants were instructed to indicate how often they had been bothered by a set of affective symptoms (e.g., "Feeling nervous, anxious, or on edge"; response scale: 0 = *not at all*, 1 = *several of the days*, 2 = *over half the days*, 3 = *nearly every day*) when thinking about climate change and other global environmental conditions (e.g., global warming, ecological degradation, resource depletion). We identified a range of environmental problems in these instructions because research suggests people are anxious about more than just climate change (see Edwards, 2008; Helm et al., 2018). A two-week time frame was used in the instructions so that the scale could be used to monitor participant scores over time and so scores could be compared across people (see also the DASS-21 and GAD-7)

(Lovibond and Lovibond, 1995; Spitzer et al., 2006). Descriptive statistics and reliability information for measures used in Study One are presented in Table 1.

The focus of people's eco-anxiety was measured by asking participants to rate their anxiety levels (from 0 = *never*, 1 = *sometimes*, 2 = *often*, 3 = *almost always*) when thinking about seven environmental threats (e.g., climate change, species extinction, ecological degradation) and six individual behaviours that contribute to the environmental crisis (e.g., their personal carbon footprint, meat consumption).

Self-identified eco-anxiety was measured by asking participants to self-identify the extent to which they experienced eco-anxiety (0 = *not at all*, 1 = *sometimes*, 2 = *often*, 3 = *almost always*) after they were informed of its definition ("The term 'eco-anxiety' is used to describe the mental and emotional distress an individual may experience in response to the threat of climate change and global environmental problems").

Open-ended questions included "What emotions do you feel when thinking about climate change?" and "In your own words describe how your anxiety or distress about climate change and global environmental problems impacts you (e.g., impacts your mood, sleeping and eating habits, relationships, ability to work or study)."

Belief in climate change was measured using two related items from Milfont et al. (2015): "climate change is real" and "climate change is caused by humans", with responses recorded along a 7-point scale (1 = *strongly disagree*, 7 = *strongly agree*).

Life satisfaction was measured using Diener et al.'s (1985) 5-item Satisfaction with Life Scale. Participants indicated the extent to which they are satisfied with their life (e.g., "In most ways my life is close to my ideal") from 1 (*strongly disagree*) to 7 (*strongly agree*).

Generalised anxiety was measured using the GAD-7 scale (Spitzer et al., 2006). Participants indicated how often they had been bothered by symptoms of GAD over the last two weeks (e.g., "Feeling nervous, anxious, or on edge") along a 4-point scale (0 = *not at all*, 1 = *several of the days*, 2 = *over half of the days*, 3 = *nearly every day*).

2.4 Results and discussion

2.4.1 Self-identified eco-anxiety. Just over one third (34.2%) of participants indicated they never experience eco-anxiety, 54.7% experience eco-anxiety some of the time, 9.3% experience eco-anxiety often, and 1.8% reported they almost always experience eco-anxiety. This suggests

that people relate with the term, and definition provided, and many feel they have experienced eco-anxiety, thus further justifying the need for an eco-anxiety scale.

2.4.2 Dimensionality of affective symptoms of eco-anxiety. After confirming assumptions were met¹, we conducted Principal Components Analysis (PCA) on our 7-item affective symptoms of eco-anxiety scale. The scree plot and Kaiser's criterion supported a single factor solution explaining 67.12% of the variance. All seven items loaded strongly on this factor (all $> .77$), which was interpreted as capturing the affective symptoms of eco-anxiety. The scale demonstrated excellent internal reliability ($\alpha = .92$; see Table S1 for factor loadings).

2.4.3 The focus of people's eco-anxiety. We also conducted PCA to determine the dimensionality of the focus of people's eco-anxiety (13-items). The scree plot and Kaiser's criterion supported a two-factor solution. Two items with low primary loadings and high cross-loadings were removed (anxiety about: "Your carbon footprint", "Your air travel"), and the resultant 11-item, two-factor solution explained 73.52% of the variance. The first factor captured anxiety focused on environmental problems, and the second factor represented anxiety about one's personal impact on the planet (see Table S2 for factor loadings), with factors strongly correlated ($r = .61$).

To test whether affective symptoms of eco-anxiety were solely experienced in relation to environmental problems, or if concerns about one's personal impact also contributed, we used Multiple Linear Regression (MLR) with each focus as a predictor. Environmental problems anxiety and personal impact anxiety *together* explained 16.7% of the variance in affective symptoms of eco-anxiety, $R^2 = .17$, $p < .001$, and *each* focus was a unique significant predictor (environmental problems anxiety: $\beta = .26$, $p < .001$; personal impact anxiety: $\beta = .19$, $p = .003$; Table S3). This finding demonstrates anxiety about environmental problems and anxiety about one's impact on the planet independently contribute to the experience of eco-anxiety, yet this latter aspect of eco-anxiety is not captured by existing scales in this area.

2.4.4 Content analyses. We analysed participants' responses to the open-ended questions and present results of content analysis in Table 2. Just under two-thirds of the sample reported feeling apprehensive about the environmental crisis (e.g., feeling anxious, worried, concerned, nervous; 66.47%), which parallel the items in our affective eco-anxiety scale. Importantly, participants reported that their eco-anxiety impacted their mood and emotionality, daily routine behaviours (including food consumption, sleeping), concentration and thinking capacity

(including ruminative thoughts), social functioning, ability to work and/or study, and caused some participants to feel restless, agitated and tense. These latter aspects of eco-anxiety were not captured by the initial 7-item affective symptoms of eco-anxiety scale but provided support for our contention that eco-anxiety is multidimensional.

2.4.5 Concurrent and discriminant validity. Kendall's tau-b correlation showed that affective symptoms of eco-anxiety were positively and moderately related to self-identified eco-anxiety (Kendall's $\tau_b = .43$), indicating the more participants resonated with the definition of eco-anxiety, the more they experienced affective symptoms. Pearson's correlations confirmed that affective symptoms of eco-anxiety were positively related to GAD scores (though the association was not so strong as to indicate they are the same construct, $r = .38$), negatively and weakly related to life satisfaction, and (unexpectedly) unrelated to climate change beliefs (see Table S4). This suggests that while people may believe in anthropogenic climate change, they do not necessarily experience the affective symptoms of eco-anxiety. Further, these results indicate that affective symptoms of eco-anxiety is a unique construct, distinct from GAD (see also Supplementary Materials), life satisfaction and beliefs in climate change. This suggests that people who do *not* suffer from forms of anxiety at a clinical or subclinical level may still experience eco-anxiety (Pihkala, 2020), thus further supporting eco-anxiety as a distinct construct.

2.4.6 Study One conclusions. Our exploration of the dimensionality of eco-anxiety in Study One demonstrates that people's anxieties about climate change and other specific environmental crises are interconnected and merge together to form an undifferentiated dimension. If we instead observed distinct factors (i.e., a factor representing climate anxiety and another representing anxiety about ecological degradation), this would have suggested climate change anxiety is distinct from (rather than subsumed within) eco-anxiety. In addition, Study One provides quantitative evidence that anxiety about environmental problems and anxiety about negatively impacting the planet are both important aspects of eco-anxiety. We anticipate that the remaining variance in affective symptoms of eco-anxiety (that was not explained by environmental problems anxiety and personal impact anxiety) may be accounted for by general psychological and emotional distress, and a range of individual and contextual factors (e.g., demographic factors, environmental concern, perceptions of risk, and direct and indirect experience of environmental crises), though this requires further investigation. Qualitative

responses indicate that eco-anxiety is also experienced as behavioural/social symptoms and ruminative cognitions, which is consistent with case studies (e.g., Dockett, 2019; Hickman, 2020), Clayton and Karazsia's (2020) scale development research, and the anxiety-rumination literature (e.g., Olatunji et al., 2013), but no measure to date captures all of these elements of eco-anxiety. Study Two incorporates these insights by testing a larger pool of items to measure the full experience of eco-anxiety.

3.0 Study Two

Considered in light of the broader literature on eco-anxiety, we used our findings from Study One to develop a more comprehensive eco-anxiety scale in Study Two. In addition to the affective symptoms captured by the initial 7-item scale, we designed new prospective items to measure our novel dimensions of eco-anxiety: behavioural and social impairments, anxiety about one's negative impact on the planet, and eco-anxiety-driven rumination (i.e., ruminating on environmental problems). We used EFA and CFA across two samples to test our expectation that these would represent different dimensions of eco-anxiety.

To test the scale's concurrent and discriminant validity, we examined associations with climate change beliefs, trust in the credibility of science and a wide range of mental health correlates. Specifically, we expected that affective symptoms would correlate more strongly with anxiety and stress (than with depression and emotion reactivity), due to similarities in their expression. We expected behavioural symptoms would correlate similarly with anxiety, stress and depression, but less so with emotion reactivity, due to commonalities in reported behavioural symptomology. We predicted that eco-anxiety-driven rumination and anxiety about one's personal impact would relate more strongly to anxiety (compared to stress, depression and emotion reactivity), given that these constructs centre on the experience of anxiety. Although affective symptoms of eco-anxiety were unrelated to acceptance of climate change in Study One, we included acceptance of climate change and the credibility of science scale in Study Two to determine whether these variables were associated with any of the other dimensions of eco-anxiety. Given the lack of research in this area, we took an exploratory approach and did not have specific hypotheses for how these variables would relate to the facets of eco-anxiety.

Finally, we assessed the stability of eco-anxiety scores over time. Based on the stability of GAD scores (i.e., Intraclass Correlation Coefficient = .83 over a one-week period) (Spitzer et al., 2006) we predicted that affective eco-anxiety scores would be relatively stable over a 12-

week period (based on Koo and Li, 2016), though it is an open question whether the other dimensions of eco-anxiety would be maintained as strongly over time.

3.1 Method

3.2 Participants and procedure

Participants were undergraduate students at Victoria University of Wellington in New Zealand who had the opportunity to complete our measures twice in exchange for course credit. The survey was advertised first at the beginning of the university semester and a second time later in the semester, with students on average completing the two surveys 12-weeks apart. The second survey was not explicitly advertised as a follow-up survey, rather participants gave consent for the researchers to link their responses from time one and time two. This research project received ethical approval from the Human Research Ethics Committee (No. 26451).

To follow best practice and run EFA and CFA on independent samples (Worthington and Whittaker, 2006), and to run planned analyses on our longitudinal subsample, we created three independent subsets of participants from the larger dataset. The first two subsets were randomly drawn from the cross-sectional sample of students who participated in the start of semester survey (sample one: $n = 365$; sample two: $n = 370$). Sample one (79.7% female, $M_{\text{age}} = 19.90$ years, $SD_{\text{age}} = 3.59$) was used for EFA of the eco-anxiety scale, and sample size was determined by ensuring minimum EFA sample size requirements were met (Comrey and Lee, 1992). Sample two (69.7% female, $M_{\text{age}} = 19.42$, $SD_{\text{age}} = 2.87$) was drawn for the purpose of conducting CFA on the eco-anxiety scale (the sample size was also sufficient for this analysis; $N > 200$) (Kline, 2015).

The third subset was comprised of the longitudinal sample ($n = 189$) of students who participated in both the first and second survey. Sample three was comparable to the first two subsets along age and gender (75.1% female, $M_{\text{age}} = 19.13$, $SD_{\text{age}} = 2.71$), and was used to determine test-retest reliability of the eco-anxiety (sub)scales. Sample size was sufficient based on Bujang and Baharum (2017), who recommend a sample size of 152 for two observations, a minimum ICC of .20 and power of .80.

3.3 Measures

Eco-anxiety was measured with the original 7-item affective symptoms of eco-anxiety measure, and an additional three items measuring ruminative thoughts relating to environmental issues (e.g., “Unable to stop thinking about future climate change and other global environmental

problems”), three items measuring impairment to behavioural and social functioning (e.g., “Difficulty working and/or studying”), and three measuring anxiety about one’s impact on the planet (e.g., “Feeling anxious about the impact of your personal behaviours on the earth”). This allowed us to test a potential 16-item scale that captured the full experience of eco-anxiety (see Table S5 for the full 16-item scale, and Appendix A for the final 13-item scale). The same instructions were provided as in Study One and responses were measured along the same 4-point frequency scale (0 = *not at all*, 3 = *nearly every day*).

Depression, Anxiety and Stress symptoms were measured using the Depression Anxiety Stress Scale (DASS-21) (Lovibond and Lovibond, 1995). Seven items measured each subscale: depression (e.g., “I couldn’t seem to experience any positive feeling at all”), anxiety (e.g., “I felt I was close to panic”) and stress (e.g., “I found it hard to wind down”). Participants indicated how much/often they have experienced each symptom over the last week using a 4-point scale (0 = *did not apply to me at all – Never*, 3 = *applied to me very much, or most of the time – Almost always*).

Emotion reactivity was measured using the 21-item Emotion Reactivity Scale (Nock et al., 2008). Participants indicated how they experience emotions on a regular basis (e.g., “I tend to get very emotional very easily”) using a 5-point scale (0 = *not at all like me*, 4 = *completely like me*).

Climate change belief was measured using the same two items as in Study One.

Credibility of Science was measured using the 6-item Credibility of Science Scale (Hartman et al., 2017). Participants indicated their evaluations of science (e.g., “People trust scientists a lot more than they should”) along a 7-point scale (1 = *strongly disagree*, 7 = *strongly agree*), which was then recoded so that higher scores indexed greater perceived credibility.

3.4 Results and discussion

3.4.1 Dimensionality of eco-anxiety. After confirming assumptions were met, we conducted principal components analysis (using oblimin rotation) on the 16-item eco-anxiety scale using sample one. Results revealed a clearly defined four-factor solution. Three complex items with low primary loadings and high cross loadings were removed: “Being so restless that it’s hard to sit still”, “Trouble relaxing”, and “Becoming easily annoyed or irritable” (Table S5), suggesting that while these experiences are central to generalised anxiety, they are not characteristic of eco-anxiety. The resultant four-factor 13-item final solution ($n = 343$ due to

listwise deletion; factor loadings are presented in Table 3) explained 82.15% of the variance. The first factor represents feelings of anxiety, accounting for 50.06% of the variance. The second factor (20.09%) represents ruminative thoughts about negative environmental events. The third factor (6.33%) represents behavioural symptoms of eco-anxiety, including difficulty sleeping, working and/or studying, and socialising with others. The fourth factor (5.67%) represents anxiety about one's personal impact on the planet. The subscales demonstrated excellent internal reliability (Table 4).

To confirm this factor structure, we conducted CFA with sample two ($n = 342$ due to the listwise deletion) using Lavaan (Rosseel, 2012) in RStudio. We compared the four-factor model to a one-factor model². The four-dimensional model showed better model fit: $\chi^2(59) = 200.96$, CFI = .96, TLI = .95, RMSEA = .08 (90% CI [.07, .10]), SRMR = .07 (see Table 5 for factor loadings), compared to the one-dimensional model: $\chi^2(65) = 1568.88$, CFI = .58, TLI = .50, RMSEA = .26 (90% CI [.25, .27]), SRMR = .19; $\Delta\chi^2(6) = 1367.92$, $p < .001$. Support for the four-factor model in both independent samples demonstrates that eco-anxiety is a multidimensional construct, comprised of affective symptoms, rumination, behavioural symptoms and anxiety about one's personal impact on the planet.

3.4.2 Concurrent and discriminant validity. Descriptive statistics for (and correlations between) mean scores on each eco-anxiety subscale and correlates are shown for sample one in Table 4 and sample two in Table S6. The mean scores for the dimensions of eco-anxiety indicate that on average people experience each facet of eco-anxiety for several of the days over a two-week period. A high mean score for belief in climate change indicates that participants tend to accept anthropogenic climate change. Correlations demonstrate that the eco-anxiety subscales were either moderately or strongly correlated with one another, although behavioural symptoms and rumination were weakly related in sample one. Therefore, individuals who often experience affective symptoms are also likely to experience behavioural symptoms, and those who occasionally experience affective symptoms typically do not experience behavioural impairments. Likewise, those who ruminate on environmental issues are likely to experience more anxiety about their personal impact on the planet, and the converse: people who are largely unconcerned about their personal impact on the planet likely spend little time thinking about environmental problems. Moreover, ruminating on environmental issues does not necessarily translate to more affective and behavioural symptoms, and one may

experience affective/behavioural symptoms relatively independently from ruminative or personal impact concerns. These patterns of associations could indicate the existence of different profiles of eco-anxiety, that is, subpopulations reporting distinct combinations of scores across each of the dimensions of eco-anxiety (e.g., low affective/behavioural symptoms, high ruminative/personal impact-focused eco-anxiety). One avenue worth exploring is whether particular combinations of scores may help to identify someone at risk of ‘severe’ or debilitating eco-anxiety, and whether there may be certain distributions of scores across the four dimensions that result in favourable mental health and behavioural outcomes (e.g., PEB).

Consistent with predictions, affective and behavioural symptoms generally related more strongly to mental health outcomes, including stress, depression and anxiety. The four dimensions of eco-anxiety were unrelated to trust in the credibility of science. Correlations with acceptance of climate change varied; in sample one, rumination and anxiety about personal impact were weakly and positively correlated with beliefs in climate change, and in sample two there was a weak positive relationship between acceptance of climate change and affective symptoms and personal impact anxiety. This suggests associations between acceptance of climate change and personal impact anxiety were relatively consistent across samples, but that beliefs about climate change do not always coincide with greater endorsement of the other three eco-anxiety facets. If this is the case, climate change deniers may be eco-anxious for different reasons (e.g., economic concerns), however this warrants further investigation.

We next examined the unique relationships between each of the eco-anxiety dimensions and the DASS-anxiety subscale. We did this using MLR, examining relationships with one dimension of eco-anxiety at a time and while controlling for the other three eco-anxiety dimensions. This demonstrated that affective symptoms was the only significant predictor of overall anxiety as measured by the DASS-anxiety subscale (Sample 1: $\beta = .42, p < .001$; Sample 2: $\beta = .52, p < .001$). With affective and other symptoms controlled, rumination (S1: $\beta = -.02, p = .814$; S2: $\beta = .03, p = .640$), behavioural symptoms (S1: $\beta = -.01, p = .908$; S2: $\beta = .01, p = .870$), and anxiety about one’s impact on the planet (S1: $\beta = .10, p = .144$; S2: $\beta = .11, p = .087$) were each unrelated to general anxiety. Given that eco-anxiety is *not* considered a pathological illness or clinical disorder, and our research (in conjunction with existing literature) demonstrates eco-anxiety is comprised of more than just affective symptoms, this finding provides further support for the distinction between eco-anxiety and general anxiety.

3.4.3 Internal and test-retest reliability (sample three). The subscales demonstrated excellent internal reliability at both time points ($\alpha > .82$ for all subscales). To test the stability of eco-anxiety scores over time ($n = 162$ due to incomplete pairs of scores), we calculated Intraclass Correlation Coefficient (ICC) estimates for each subscale. These were based on a mean-rating ($k = 2$), absolute-agreement, 2-way mixed-effects model (Koo and Li, 2016). We found that affective and behavioural symptoms were less stable over time than rumination and personal impact anxiety, as indicated by weaker ICCs (affective symptoms: ICC = .55, 95% CI [.39, .67]; behavioural symptoms: ICC = .58, 95% CI [.41, .70]; rumination: ICC = .67, 95% CI [.55, .76]; personal impact anxiety: ICC = .74, 95% CI [.65, .81]).

3.4.4 Study Two conclusions. Taken together, our findings support eco-anxiety as a quantifiable psychological experience that is reliably measured using the 13-item Hogg Eco-Anxiety Scale (HEAS-13; Appendix A). Each dimension of eco-anxiety demonstrated good internal reliability and strong discriminant validity, with interesting patterns emerging in the correlations between the eco-anxiety subscales and mental health measures, and personal impact anxiety and acceptance of climate change. Findings on the stability of the dimensions of eco-anxiety suggest that some aspects of eco-anxiety are persistent over time (rumination and personal impact anxiety), while others (affective and behavioural symptoms) fluctuate more across time. It is possible that symptomatic eco-anxiety is more responsive to environmental stimuli, including major environmental events (e.g., weather events and natural disasters) and representations of climate change in the media, which are typically designed to increase awareness and concern about environmental issues. Meanwhile, ruminative and personal impact concerns may persist to a greater extent over time as they are driven and maintained by cognitions (e.g., thoughts about the environment and one's personal behaviours). However, it is possible that we would observe more gradual changes in symptoms of eco-anxiety over a shorter timeframe (e.g., two to four weeks). Indeed, further research on the stability of eco-anxiety dimensions, and contextual factors that ameliorate or exacerbate eco-anxiety, is warranted.

5.0 Discussion

Our programme of research documented experiences of anxiety in response to the environmental crisis, culminating in a comprehensive new eco-anxiety scale. In successfully validating this multidimensional measure of eco-anxiety, we contribute to the existing literature in several notable ways. Our measure is the first and only validated measure of eco-anxiety that

captures anxiety in response to the global environmental crisis, making it distinct from existing scales that specifically measure climate change anxiety (e.g., Clayton and Karazsia, 2020; Helferich et al., 2020; Materia, 2016). In addition, we establish eco-anxiety as a multidimensional construct, comprised of four underlying factors.

Consistent with Clayton and Karazsia's (2020) climate change anxiety measure, we identified affective and behavioural symptoms as important characteristics of eco-anxiety. Although Clayton and Karazsia's cognitive-emotional impairment facet blended negative emotionality, cognitive disturbance and some physical manifestations, such as crying and difficulty sleeping, these symptoms are disentangled into different subfactors of the HEAS-13; assessing negative emotionality within a distinct affective subscale, and showing this dimension relates to experiences of mental ill-health in distinct ways to the behavioural dimension. Similar to Clayton and Karazsia, we found that rumination (in the HEAS-13, this is in the form of eco-anxiety-driven rumination) was an important aspect of eco-anxiety, with meaningful patterns of associations. Our research contributes new findings to the climate change anxiety and eco-anxiety literature by showing anxiety about one's personal impact is a unique dimension of eco-anxiety with distinct correlates. Overall, our accumulated evidence on eco-anxiety and climate change anxiety enhances our confidence in the existence of affective and behavioural impairments and rumination, and can forge new research on the role of personal impact anxiety.

Previous researchers have argued that it is difficult to differentiate eco-anxiety from clinical and subclinical forms of anxiety (Helm et al., 2018; Pihkala, 2018; Swim et al., 2009). Further complicating past conceptualisations of eco-anxiety, various emotions and mental states often co-occur, and are therefore difficult to disentangle; an individual may feel depressed first and foremost, but in the background also experience eco-emotions, such as eco-anxiety (Pihkala, 2018). However, we showed that affective and behavioural symptoms of eco-anxiety were mostly moderately related to negative mental health outcomes, indicating that while there is some overlap between constructs, the underlying dimensions of eco-anxiety are, in fact, distinct from stress, anxiety and depression. In addition, the tendency to ruminate on environmental events and anxiety about one's personal impact were significantly related to mental health outcomes and emotion reactivity. Although these associations were weak to moderate by Cohen's (1988) guidelines, and suggest that many people who experience these dimensions of eco-anxiety may not simultaneously experience poor mental health, the finding dovetails with a

growing body of research that indicates negative eco-emotions may be modest but consistent correlates and predictors of self-rated mental ill-health (Ogunbode et al., 2021; Stanley et al., 2021; Stewart, 2021) and sleep problems (Ogunbode et al., 2021). It is also worth noting that in other research contexts correlations around .30 have meaningful practical and real-world implications, for example, neuroticism is a robust predictor of various anxiety disorders, with correlations varying around .30 (Kotov et al., 2010). Additionally, social psychological effects are typically consistent with an r -value of .21 (Richard et al., 2003). As such, the extent to which eco-anxiety facets relate to health and wellbeing constructs should not be overlooked.

Our results demonstrate that the HEAS-13 is a useful tool for scholars and clinicians interested in measuring anxiety in response to the environmental crisis. In addition, the brief (13-item) nature of the HEAS-13 makes it an easily administered tool. We recommend that researchers calculate a mean score for each dimension of eco-anxiety, with higher scores indicating a greater average of frequency. We note that the HEAS-13 assesses how an individual has generally felt over the last two weeks (as per the scale instructions), and is therefore designed to measure *enduring* forms of eco-anxiety, consistent with our findings on its relative stability over time. The HEAS-13 will facilitate monitoring eco-anxiety over time and interrogating the causes and correlates of eco-anxiety. For example, our scale could be used to assess how eco-anxious people in the community generally are, or the extent of eco-anxiety experienced in the aftermath of an extreme weather event or natural disaster (e.g., two weeks post bushfire), and during longer term recovery (e.g., 6-12 months post disaster). Because of this focus on enduring forms of eco-anxiety, the HEAS-13 is not recommended for capturing *reactive* states of eco-anxiety—transient eco-anxious responses to adverse conditions at a specific moment in time.

There are many reasons for and benefits of taking a broader perspective to examine anxiety in relation to a multitude of environmental issues. Our research, in conjunction with media reports, case studies and existing literature (e.g., Dockett, 2019; Hickman, 2020; Pihkala, 2020), demonstrate that eco-anxiety is a quantifiable phenomenon and important part of people's lived experience. Therefore, it is appropriate to consider when trying to better understand environmentally related anxiety, separate from or in conjunction with (sub)clinical forms of anxiety an individual may experience. Conceptually, eco-anxiety sits at a higher level of abstraction and in the context of research, may pair well with other similarly high-level human behaviours, including PEBs. However, researchers may be interested in specific categories of

human behaviour, such as low carbon behaviours, and if this is the case then measuring anxiety in relation to specific environmental conditions, such as climate change, is certainly warranted. While Clayton and Karazsia's (2020) Climate Change Anxiety Scale is a useful tool, we also present guidelines for adapting the instructions and items of the HEAS-13 to measure anxiety relating to specific environmental problems (e.g., climate change, global warming, ecological degradation, pollution, deforestation; refer to Supplementary Materials). Employing adapted versions of the HEAS-13 for validation is a promising next step for future research, and adherence to these guidelines will facilitate consistent measurement across studies.

It is worth noting that our research does not intend to psychopathologise eco-anxiety. We, along with many other researchers, warn against pathologising psychological and emotional responses to the environmental crisis, because doing so assumes these responses are maladaptive, unhelpful, or disproportionate to the threat posed (e.g., Clayton, 2020; Clayton and Karazsia, 2020; Hickman, 2020; Pihkala, 2020). Eco-anxiety and climate change anxiety are *rational* responses, given the enormity of the crisis (Lawton, 2019; Pihkala, 2020). Perhaps what is most important is understanding and supporting people with varying degrees of eco-anxiety, and recognising that severe eco-anxiety (as indicated by higher scores on our eco-anxiety subscales) can be debilitating and paralysing (Hickman, 2020; Pihkala, 2020). Further, to the extent one's day to day functioning and quality of life are affected, eco-anxiety may merit clinical attention (Taylor, 2020). As our sample largely experienced mild eco-anxiety (mean scores corresponding to experiencing dimensions of eco-anxiety for several of the days across a two-week period), we cannot make inferences about those at the top end of the eco-anxiety scale from our data. Addressing this limitation will involve future research with individuals suffering from high levels of eco-anxiety to understand their experiences and how to support them. Indeed, psychologists are uniquely positioned within the health industry to assess and attend to individual differences in experiences and presentations of eco-anxiety. Further research to validate the HEAS-13 in clinical samples and establish clinical norms of eco-anxiety would facilitate its use in clinical settings as a potential screening tool to identify individuals suffering with severe eco-anxiety, compared to those in the general population.

Research attention on the co-morbidity of eco-anxiety and mental illness (e.g., Obsessive Compulsive Disorder, eating disorders, Major Depressive Disorder, delusional guilt) should also continue. While we found that eco-anxious people do not necessarily report symptoms of

psychological disorders, Hickman (2020) suggests that individuals may experience more complex and severe eco-anxiety due to existing mental health problems. For example, Hickman proposes an individual with Obsessive Compulsive Disorder might compulsively check climate science publications. This behaviour could stem from the disorder itself, or be the result of severe eco-anxiety, or the interaction of both (Hickman, 2020).

Because young adults are especially at risk of experiencing climate change anxiety (e.g., Clayton and Karazsia, 2020; Searle and Gow, 2010), our initial focus on university student samples was an important first population to explore. However, our samples were predominantly female, and without a nationally representative sample, our research cannot estimate the prevalence and severity of eco-anxiety among the general population, which is the next step for this research. Consistent with this line of research, we recommend investigating and comparing the prevalence and manifestation of eco-anxiety and its distinct dimensions amongst different populations of people, such as young people and women (Clayton et al., 2014; USGCRP, 2016), and those residing in areas most susceptible to the impacts of climate and environmental change (Hayes et al., 2018). For example, because young people's futures will be more affected by environmental crises, future research could test whether young people experience greater affective and behavioural symptoms than older adults (Burke et al., 2018; Hickman, 2020). While our 13-item scale is uniquely positioned to test this sort of question, its application to the Global South and to Indigenous peoples requires further investigation, as our research drew samples from two developed Western countries. It is possible that eco-anxiety will manifest differently (e.g., with different dimensions, or different associations) in the Global South, where people are disproportionately affected by the negative consequences of climate change, with limited capacity to prevent, adapt and recover from such consequences. Anecdotal evidence suggests that those at the forefront of climate injustice experience eco-anxiety as a combination of frustration, anger, rage and burnout, while those in the developed world feel a greater sense of anxiety, guilt and personal responsibility for contributing to the problem (Wray, 2021).

Another promising avenue for future research is to explore the antecedents of eco-anxiety, including (in)direct experience of environmental crises. Most people regularly experience climate change and other environmental problems indirectly via the media or public discourse (Doherty and Clayton, 2011; Reser and Swim, 2011; Swim et al., 2009). The resulting awareness of climate change and fear of the unknown is sufficient to cause psychological distress

(Clayton and Karazsia, 2020). Thus, direct exposure to environmental problems is not a necessary precondition to suffering negative mental health outcomes (Swim et al., 2009). However, as the environmental crisis worsens, increasing numbers of people will experience environmental problems directly, and while the resultant effect on eco-anxiety is as yet unknown, direct experience with ecological problems will likely become an increasingly prevalent antecedent.

In addition to exploring the antecedents of eco-anxiety, we recommend further study on whether certain levels on each dimension of eco-anxiety are optimal for both the individual and the planet (e.g., promote PEB without endangering individual wellbeing). As noted earlier, rumination and anxiety about one's personal impact on the planet do not directly contribute to negative mental health outcomes and may promote engagement in PEB. For example, it is expected that ruminating on environmental events will motivate people to engage in PEBs that help mitigate environmental crises (Hornsey et al., 2016), and keeping environmentalism 'top of mind' through repeated thoughts may reduce one of the dragons of climate inaction (Gifford, 2011). Similarly, an anticipated outcome of feeling anxious about personally contributing to the state of the planet is that people will engage in environmental activism and/or adopt low carbon lifestyles to reduce their impact on the environment. Conversely, research should also examine whether there are aspects of eco-anxiety that are harmful for the individual, and in turn the planet. For example, impaired behavioural functioning related to eco-anxiety (e.g., difficulties sleeping) may hinder engagement in PEB.

The relationship between eco-anxiety and PEB is important, especially because engaging in PEB may prove to be an effective strategy for coping with eco-anxiety, particularly if it is in a context of high collective and participative efficacy (Bamberg et al., 2015). Examining the effectiveness of intervention strategies that are designed to help individuals manage their eco-anxiety, including therapies centered on PEB, is an important avenue for future research. Organisations such as the Australian Psychological Society and Reach Out provide general resources to the community about coping with eco-anxiety, including advice to engage in PEBs, maintain strong social support networks, and a sense of hope. However, there is limited evidence for these interventions, which is required to ensure the effective implementation and communication of intervention strategies within the community.

5.1 Conclusions

Our research has shown that eco-anxiety is a quantifiable and multifaceted psychological experience. The Hogg Eco-Anxiety Scale (HEAS-13) exhibited a unique four-dimensional structure and a high degree of reliability and validity. The dimensions of eco-anxiety varied in stability and had interesting patterns of associations with mental health measures and beliefs about climate change. Researchers and clinicians can use this scale to assess how eco-anxious people in the community generally are, and monitor eco-anxiety scores over time, especially in the wake of significant environmental events. We encourage clinicians to recognise the spectrum of human experience and examine eco-anxiety within clinical populations, providing appropriate therapeutic support for individuals with severe eco-anxiety. For all those using it, the Hogg Eco-Anxiety Scale should facilitate a better understanding of the antecedents and outcomes of eco-anxiety, and the differential effects of eco-anxiety on different populations of people.

Appendix A

The Hogg Eco-Anxiety Scale (HEAS-13) instructions:

“Over the last 2 weeks, how often have you been bothered by the following problems, when thinking about climate change and other global environmental conditions (e.g., global warming, ecological degradation, resource depletion, species extinction, ozone hole, pollution of the oceans, deforestation)?”

1. Feeling nervous, anxious or on edge
2. Not being able to stop or control worrying
3. Worrying too much
4. Feeling afraid
5. Unable to stop thinking about future climate change and other global environmental problems
6. Unable to stop thinking about past events related to climate change
7. Unable to stop thinking about losses to the environment
8. Difficulty sleeping
9. Difficulty enjoying social situations with family and friends
10. Difficulty working and/or studying
11. Feeling anxious about the impact of your personal behaviours on the earth
12. Feeling anxious about your personal responsibility to help address environmental problems
13. Feeling anxious that your personal behaviours will do little to help fix the problem

Response scale: 0 = *not at all*, 1 = *several of the days*, 2 = *over half the days*, 3 = *nearly every day*.

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Table 1. Descriptive and reliability information for the measures in Study One.

Variable	<i>M (SD)</i>	Scale reliability
Affective symptoms of eco-anxiety scale	0.43 (0.56)	.92
Environmental problems anxiety	1.61 (0.77)	.94
Personal impact anxiety	1.24 (0.81)	.88
Self-identified eco-anxiety	0.79 (0.68)	-
Belief in climate change	6.13 (1.03)	.83*
Life satisfaction	4.65 (1.23)	.87
GAD	1.05 (0.85)	.93

Note. Reliability analyses reported are the Spearman-Browne coefficient for 2-item scales, and Cronbach's alpha for scales with 3 or more items. * $p < .001$.

Table 2. Content analysis findings from Study One.

Theme	Percentage of sample	Representative quote
Emotional experiences		
Apprehension (e.g., anxiety, worry, concern, nervous)	66.47%	“Anxious”, “worried”, “nervousness”
Anger (e.g., frustration, irritation)	40.42%	“Anger and frustration”
Sadness	33.83%	“Sad”
Helplessness and powerlessness	22.75%	“Helplessness”
Afraid and scared	14.37%	“Scared”, “fearful”
Hopelessness	9.58%	“Hopeless”
Stress and/or tense	8.68%	“Stress”
Impairment		
Mood and emotionality	20.06%	“Impacts my mood by making me extremely anxious”
Daily routine behaviours (e.g., food consumption, sleeping)	11.38%	“Makes me too nervous to eat” “Keeps me up at night”
Concentration and thinking capacity (e.g., ruminative thoughts)	5.99%	“Harder to concentrate, constantly think about how my actions affect the climate”
Ability to work and/or study	4.49%	“Impacts my ability to work or study”
Restlessness, agitation and tension	3.59%	“Restless” “Become more irritable and on-edge”
Social functioning (e.g., interactions and relationships with others)	3.29%	“Affects my relationships with friends and family”

Table 3. Final factor loadings from Principal Components Analysis of the 13-item eco-anxiety scale (n = 343 following listwise deletion) from Study Two, sample one.

Item	Affective symptoms	Rumination	Behavioural symptoms	Anxiety about personal impact
Feeling nervous, anxious or on edge	.845			
Not being able to stop or control worrying	.898			
Worrying too much	.821			
Feeling afraid	.881			
Unable to stop thinking about future climate change and other global environmental problems		.838		
Unable to stop thinking about past events related to climate change		.952		
Unable to stop thinking about losses to the environment		.793		
Difficulty sleeping			.762	
Difficulty enjoying social situations with family and friends			.861	
Difficulty working and/or studying			.904	
Feeling anxious about the impact of your personal behaviours on the earth				-.896
Feeling anxious about your personal responsibility to help address environmental problems				-.774

Feeling anxious that your personal behaviours will do little to help fix the problem	-.715
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Note. Factor loadings < .30 are omitted for clarity.

Table 4. Associations between eco-anxiety subscales, mental health measures and climate change belief measures from Study Two, sample one.

		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Dimensions of eco-anxiety	1. Affective symptoms	--									
	2. Rumination	.40***	--								
	3. Behavioural symptoms	.70***	.26***	--							
	4. Anxiety about personal impact	.46***	.72***	.32***	--						
Correlates of eco-anxiety	5. Stress	.42***	.22***	.30***	.27***	--					
	6. Anxiety	.46***	.22***	.31***	.28***	.75***	--				
	7. Depression	.37***	.15**	.35***	.21***	.72***	.66***	--			
	8. Emotion reactivity	.37***	.13*	.23***	.20***	.57***	.52***	.51***	--		
	9. Credibility of science	-.05	.01	-.07	.05	-.04	-.05	-.09	-.07	--	
	10. Climate change belief	.06	.14*	.01	.23***	-.05	-.03	.01	.05	.32***	--
M (SD)		0.66 (0.79)	0.33 (0.59)	0.63 (0.80)	0.55 (0.72)	0.91 (0.64)	0.76 (0.65)	0.76 (0.73)	2.65 (0.90)	5.00 (1.19)	6.20 (0.81)
Scale reliability		.92	.90	.86	.88	.83	.83	.91	.95	.90	.64***

Note. Reliability analyses reported are the Spearman-Browne coefficient for 2-item scales, and Cronbach's alpha for scales with 3 or more items. *** $p < .001$, ** $p < .01$, * $p < .05$.

Table 5. Standardised factor loadings from the Confirmatory Factor Analysis (n = 342) of the 13-item eco-anxiety scale (Study Two, sample two).

Item	Affective symptoms	Rumination	Behavioural symptoms	Anxiety about personal impact
Feeling nervous, anxious or on edge	.898			
Not being able to stop or control worrying	.937			
Worrying too much	.925			
Feeling afraid	.642			
Unable to stop thinking about future climate change and other global environmental problems		.862		
Unable to stop thinking about past events related to climate change		.806		
Unable to stop thinking about losses to the environment		.931		
Difficulty sleeping			.795	
Difficulty enjoying social situations with family and friends			.783	
Difficulty working and/or studying			.847	
Feeling anxious about the impact of your personal behaviours on the earth				.858
Feeling anxious about your personal responsibility to help address environmental problems				.913

Feeling anxious that your personal behaviours will do little to help fix the problem	.827
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Footnotes

¹Visual examination of the scatterplots and inspection of the skewness statistic confirmed associations between items were linear and data were normally distributed and suitable for analysis (Kaiser-Meyer-Olkin statistic = .90; Bartlett's test of sphericity $p < .001$).

²We also confirmed the four-dimensional model exceeded two- and three-dimensional models, and results are presented in the Supplementary Materials.