
NATURAL EFFECTS
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You know that exercise is good for you, though did you know its health benefits are greatly magnified if undertaken in a forest? Just standing in a forest taking in the view can improve your mood and cognitive function. Even sitting in a chair looking at a photo of the view is good for you.

And it is not just seeing nature that is beneficial, hearing it helps and smelling it is a form of aromatherapy that has been attributed with improving vascular health, regulating hormones, strengthening immunity, fighting cancer and reducing blood sugars.

Natural settings also provide opportunities for spiritual experiences, enhancing self-esteem, facilitating socialisation and encouraging optimal development in children.

A walk in the bush is not a cure all, but it is good for you in many ways.

Throughout most of human evolution we have lived within natural environments and thus had an intimate relationship with nature, making people physiologically and psychologically adapted to nature. Most people are now separated from the natural world on a daily basis. It is argued that people have a biologically based need to affiliate with and feel connected to the natural world, the term biophilia is used to describe "*the connections that human beings subconsciously seek with the rest of life*" (Wilson 1984).

There is a belief that our divorce from nature may be having adverse effects on our well-being, and there is increasing evidence that interactions with nature for recreation and enjoyment do have a multitude of beneficial effects.

A review was undertaken of 116 scientific papers investigating the affects that nature has on people. They provide abundant evidence that exposure to natural environments reduces most people's psychological and physiological (i.e. pulse rate, blood pressure, cortisol, salivary amylase, adrenaline) indicators of stress, while improving their mood and happiness. The experience can overcome mental fatigue and restore cognitive function.

To varying extents, significant effects have been found to result from a trek through a wilderness, a walk in the park, looking at views, looking at paintings or photographs, and even from the anticipation of a visit to a forest. Views of trees from hospital windows have been found to foster faster recovery from surgery, though it is a walk in a forest that has the greatest health benefits.

A walk through a forest influences people's well-being through our senses of sight, hearing, and smell. Organic particles suspended in the air appear to be particularly influential. Trees remove human pollutants and contribute beneficial bacteria, negatively-charged ions and phytoncides to the air we breathe. Phytoncides are organic compounds that plants produce to communicate between themselves and with other organisms.

Japanese studies of 'forest air-bathing' (Shinrin-yoku) show that as we walk among the trees we breathe in phytoncides, taking in their health benefits as a form of natural aromatherapy. There is growing evidence that, as well as contributing to stress reduction, various

phytoncides can affect our health by improving our cardiovascular system, strengthening our endocrine and immune systems, enhancing anti-cancer proteins and reducing blood sugars.

Nature experiences can invoke wonder and awe, whether it is encountering a massive ancient tree, an unusual encounter with an animal, seeing a spectacular scene, or being immersed in a wilderness remote from civilisation. Such experiences can create deep emotional and spiritual experiences - a momentary loss of sense-of-self, immersion in the present moment, a sense of harmony with the world - which sometimes can be life changing.

The natural environment can provide many physical challenges, from a child climbing a tree to an adult scaling a mountain. Overcoming the risk, fear and uncertainty associated with particularly challenging activities in nature can have significant and long-lasting effects on self-esteem.

Natural environments have been found to encourage more altruistic and cooperative behaviour, whether from watching a video, a walk in the park or a hike through wilderness. In America adventure recreation in wilderness areas has long been used to foster greater self esteem, sense of community and long-term cooperative behaviours, particularly for troubled youths.

Whether we subconsciously seek connections with the natural world is a moot point, as there is abundant evidence that experiencing nature is beneficial to our health and wellbeing. A walk in a forest makes you feel better, improves your health and is likely to be doing far more good than you realise.

Find a forest, breathe deeply, relax and let nature help heal your body and mind.

CONTENTS


1. HOW NATURE AFFECTS YOU

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Recreation in natural environments has long been promoted for its physical and mental health benefits. Back in 1865 Olmsted (cited by Kaplan 1995) summarised what he perceived the benefits to be:

> *natural scenery employs the mind without fatigue and yet exercises it; tranquilizes it and yet enlivens it; and thus, through the influence of the mind over the body, gives the effect of refreshing rest and reinvigoration to the whole system*'

Research supports this perception. Tsunetsugu *et. al.* (2010) describe the process of how nature affects us through all our senses:

> *Forest environments affect humans via the five senses, providing stimulation of various senses, such as vision (scenery), olfaction (smell of wood), audition (sound of running streams or the rustle of leaves), tactile sensation (feel of the surfaces of trees and leaves). Sensory information inputs via the five senses are processed in the corresponding sensory areas of the brain and are further transmitted through interaction among the various sensory inputs. These signals subsequently reach the areas of the brain that control emotions and physiological functions, where they effect physiological changes.*

Studies to quantify the affects on people of recreation in natural areas gained momentum in the 1980's, most notably with a growing interest in America of the benefits of wilderness experiences, particularly adventure recreation, and the decision by the Japanese government to promote forest air-bathing ("Shinrin-yoku") for relaxation and stress management. From 2004 the Japanese Government significantly increased understanding with a series of projects investigating the physiological effects of forest recreation.

There is now a large body of evidence attesting to the benefits of the natural environment on the physical health and mental wellbeing of people. Many studies have been based on subjects self-reporting of perceived benefits, though these have been supported by a variety of tests of cognitive function and, more recently, numerous controlled studies of physiological effects. Many of these have involved comparisons between recreation in forest and urban areas, with both walking and sitting (Yamaguchi *et. al.* 2006, Tsunetsugu *et. al.* 2007, Park *et. al.* 2007, Park *et. al.* 2009, Lee *et. al.* 2009, Park *et. al.* 2010, Mao *et. al.* 2012, Berman *et. al.* 2012, Ochiai *et. al.* 2015, Song *et. al.* 2015a, Song *et. al.* 2015b, Song *et. al.* 2016).

Table 1. Findings of studies and reviews into how exposure to nature affects people.

NATURE EFFECTS ON PEOPLE	STUDIES AND REVIEWS
Psychological	
reducing stress	Talbot and Kaplan 1986, Kaplan 1995, Laumann *et. al.* 2001, Yamaguchi *et. al.* 2006, Morita *et. al.* 2006, Velarde *et. al.* 2007, Mayer *et. al.* 2009, Park *et. al.* 2009, Li 2010, Kjellgren and Buhrkall 2010, Foster and Borrie 2011, Kim *et. al.* 2012, Heintzman 2012, Keniger *et. al.* 2013, Ochiai *et. al.* 2015, Song *et. al.* 2015a, Ashley *et. al.* 2015, Song *et.al*. 2016
improving mood and happiness	Talbot and Kaplan 1986, Hartig *et. al.* 1991, Ulrich *et. al.* 1991, Fredrickson and Anderson 1999, Morita *et. al.*

	2006, Heintzman 2006, Velarde *et. al.* 2007, McDonald *et. al.* 2009, Berman *et. al.* 2012, Foster and Borrie 2011, Shin *et. al.* 2011, Heintzman 2012, Mao *et. al.* 2012, Ashley *et. al.* 2015, Song *et.al*. 2016, Yu *et. al.* 2016, Grazuleviciene *et. al.* 2016
reducing anger and aggression	Hartig *et. al.* 1991, Ulrich *et. al.* 1991, Hartig *et. al.* 2003, Morita *et. al.* 2006, Park *et. al.* 2010, Song *et. al.* 2015a
reducing tension and anxiety	Talbot and Kaplan 1986, Park *et. al.* 2010, Ashley *et. al.* 2015, Song *et. al.* 2015a
heightening self-awareness and reflection	Talbot and Kaplan 1986, Kellert 1998, Fredrickson and Anderson 1999, Mayer et. al. 2009, McDonald *et. al.* 2009, Ashley *et. al.* 2015
improving self-esteem	Ewert 1987, Rohde and Kendle 1994, Fredrickson and Anderson 1999, Paxton and McAvoy 2000, West and Crompton 2001, Garst *et. al.* 2001, McDonald *et. al.* 2009, Maller 2009, Duvall and Kaplan 2013, Dadvand *et. al.* 2015,
providing transcendent and spiritual experiences	Talbot and Kaplan 1986, Hartig *et. al.* 1991, DeMares and Krycka 1998, Kellert 1998, Fredrickson and Anderson 1999, Williams and Harvey 2001, Bath and Enck 2003, Heintzman 2006, McDonald *et. al.* 2009, Ballantyne *et. al.* 2011, Foster and Borrie 2011, Heintzman 2012, Ashley *et. al.* 2015
Cognitive function	
increasing memory and attention span	Kaplan 1995, Tennessen and Cimprich 1995, Hartig *et. al.* 1991, Wells 2000, Hartig *et. al.* 2003, Velarde *et. al.* 2007, Berman *et. al.* 2008, Taylor and Kuo 2009, Mayer *et. al.* 2009, Shin *et. al.* 2011, Berman *et. al.* 2012, Keniger *et. al.* 2013, Dadvand *et. al.* 2015, Zhang *et. al.* 2017
increasing vigor and reducing fatigue	Park *et. al.* 2010, Song *et. al.* 2015a, Yu *et. al.* 2016
reducing confusion	Park *et. al.* 2010
Social	
increasing altruistic and cooperative behaviours	Talbot and Kaplan 1986, Ewert 1987, Kellert 1998, Fredrickson and Anderson 1999, Garst *et. al.* 2001, Heintzman 2006, Maller 2009, Weinstein *et. al.* 2009, Heintzman 2012, Duvall and Kaplan 2013, Gueguen and Stefan, 2014, Zelenski et. al. 2015, Rude *et. al.* 2017
Physiological	
reducing salivary amylase activity (an indicator of stress)	Yamaguchi *et. al.* 2006, Ochiai *et. al.* 2015
improving heart rate variability	Tsunetsugu *et. al.* 2007, Kim *et. al.* 2012, Joung *et. al.* 2014, Kobayashi *et. al.* 2015, Song *et. al.* 2015a, Song *et.al*. 2016
lowering pulse rate	Ulrich *et. al.* 1991, Lee *et. al.* 2009, Kjellgren and Buhrkall 2010, Park *et. al.* 2010, Song *et. al.* 2015a, Song *et.al*. 2016
reducing blood pressure	Ulrich *et. al.* 1991, Ohtsuka *et. al.* 1998, Hartig *et. al.* 2003, Tsunetsugu *et. al.* 2007, Nam and Uhm 2008, Lee *et. al.* 2009, Park *et. al.* 2009, Kjellgren and Buhrkall 2010, Park *et. al.* 2010, Mao *et. al.* 2012, Lee and Lee 2014, Ochiai *et. al.* 2015, Grazuleviciene *et. al.* 2016
increasing parasympathetic nervous	Park *et. al.* 2010, Tsunetsugu *et. al.* 2010, Joung *et. al.*

activities	2014, Song *et.al*. 2016,
lowering sympathetic nerve activity	Park *et. al.* 2010, Tsunetsugu *et. al.* 2010
reducing cortisol levels	Tsunetsugu *et. al.* 2007, Park *et. al.* 2007, Nam and Uhm 2008, Lee *et. al.* 2009, Park et. al. 2010, Li and Kawada 2010, Tsunetsugu *et. al.* 2010, Yu *et. al.* 2016, Grazuleviciene *et. al.* 2016
reducing adrenaline in urine	Li and Kawada 2010
lowering cerebral activity in the prefrontal area	Park *et. al.* 2007
reducing Skin Conductance Responding	Ulrich *et. al.* 1991
reducing frontalis muscle tension	Ulrich *et. al.* 1991
reducing cardiovascular disease associated factors	Mitchell and Popham 2008, Mao *et. al.* 2012, Lee and Lee 2014
enhancing human natural killer cell (NK) activity	Li 2010, Li and Kawada 2010, Tsunetsugu *et. al.* 2010, Kim *et. al.* 2015
increasing anti-cancer proteins	Li 2010, Li and Kawada 2010, Tsunetsugu *et. al.* 2010, Kim *et. al.* 2015
reducing blood sugar	Ohtsuka *et. al.* 1998

What the above studies show are that:

- People's most common and consistent responses to exposure to nature are reduced stress, anxiety and anger, with improved mood and cognitive function. These affects are confirmed by an array of physical responses indicative of reduced stress, such as reduced cortisol levels, salivary amylase, pulse rate, blood pressure, adrenaline, Skin Conductance Responding, and frontalis muscle tension. Improved cognitive function has been shown in a variety of performance tests, as well as being indicated by increased parasympathetic nervous activity.
- Recreating in forests can have other significant health benefits such as reducing cardiovascular disease associated factors, enhancing human natural killer cell (NK) activity, increasing anti-cancer proteins, and reducing blood sugars. This has in part been attributed to the quality of the air in forests, particularly the presence of organic compounds (phytoncides) released by trees.
- Experiencing ancient giant trees, unusual wildlife, spectacular natural landscapes and wilderness can invoke awe and wonder, providing transcendent and spiritual experiences.
- Overcoming the challenges that can occur recreating in natural environments improves self-esteem, whether it is a child climbing a tree or an adult conquering a mountain, and doing so in company can result in long-term increases in altruistic and cooperative behaviours.

From their literature review Velarde *et. al.* (2007) identified:

> *... the main health aspects of exposure to landscapes related to reduced stress, improved attention capacity, facilitating recovery from illness, ameliorating physical well-being in elderly people, and behavioural changes that improve mood and general well-being. These effects have been addressed by means of viewing natural landscapes during a walk, viewing from a window, looking at a picture or a video, or experiencing vegetation around residential or work environments.*

Studies have consistently shown that exposure to natural environments have a range of beneficial effects on most people, though the response can vary between individuals (Shin

et. al. 2010, Lee *et. al.* 2012, Song *et. al.* 2013, Kobayashi *et. al.* 2015, Song *et. al.* 2015b). As noted by Shin *et. al.* (2010) "*differences in the user's attitude to the forest may influence differentially the user's psychological outcome from a forest experience*".

In their studies Song *et. al.* (2013) found that pulse rate and diastolic blood pressure were significantly lowered by forest therapy, though the level of the reduction varied depending on whether the subjects exhibited a Type A or Type B behaviour, with the Type A group not displaying significant changes.

Song *et. al.* (2015b) identify one cause of different responses as being physiological adjustment to an appropriate level, finding "*The subjects whose initial blood pressures and pulse rates were high showed a decrease in these values after walking in a forest environment, whereas those whose initial values were low showed an increase*".

Some people show a strong dislike for natural settings, often due to negative experiences or expectations. Interactions with the natural environment are not all beneficial as encounters with snakes, spiders or heights can create negative reactions and cause stress (i.e. Ulrich *et. al.* 1991). As compared to biophilia, this tendency is called biophobia

Kobayashi *et. al.* (2015) assessed the heart rate variation amongst 625 young male subjects in forest and urban settings, finding that there was an average increase in heart rate in forests, but that "*approximately 80% of the subjects showed an increase in the parasympathetic activity in forest environments, whereas the remaining subjects exhibited a negative effect of the forest environments*". They considered *"the negative responders in the results of the current study could be explained by ...specific phobias to living things".*

Natural Effects on Children

The effect of exposure of children to natural experiences deserves particular recognition. Children's physical involvement with nature is considered to have significant effects on their emotional, physical and cognitive development (Rohde and Kendle 1994, Wells 2000, Maller 2009, Dadvand *et. al.* 2015). As noted by Dadvand *et. al.* (2015):

> *Contact with nature is thought to play a crucial and irreplaceable role in brain development (1, 2). Natural environments including green spaces provide children with unique opportunities such as inciting engagement, risk taking, discovery, creativity, mastery and control, strengthening sense of self, inspiring basic emotional states including sense of wonder, and enhancing psychological restoration, which are suggested to influence positively different aspects of cognitive development*

It is considered that it is children's direct experience of nature in middle-childhood that has the most powerful effect on their psychosocial growth and development (Maller 2009).

Maller (2009) asked teachers and environmental educators' perceptions of the benefits of hands-on contact with nature for "normal" primary-aged school children, concluding that the perception is "*that hands-on contact with nature is important for children's mental, emotional and social health on various dimensions*".

Dadvand *et. al.* (2015) assessed the relationship between the amount of vegetation (greenness) 2,623 primary school students were exposed to and their cognitive development over 12 months, observing "*an enhanced 12-mo progress in working memory and superior*

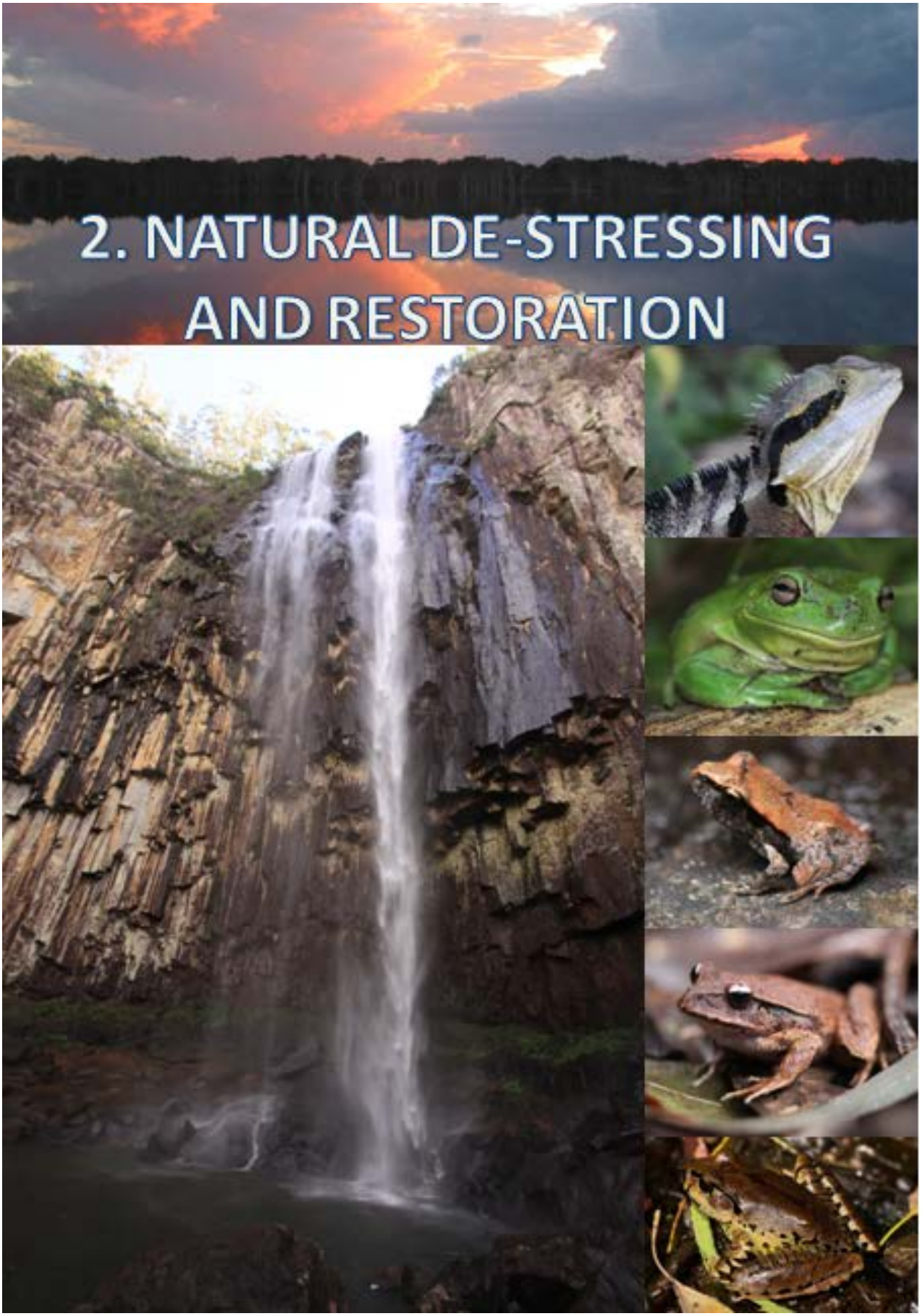
working memory and a greater 12-mo reduction in inattentiveness associated with greenness within and surrounding school boundaries and with total surrounding greenness index (including greenness surrounding home, commuting route, and school)".

Wells (2000) assessed 17 low-income children who relocated, finding those "*whose homes improved the most in terms of greenness following relocation also tended to have the highest levels of cognitive functioning following the move*". noting "*These findings suggest that the power of nature is indeed profound*".

From their retrospective surveys of 429 participants, and longitudinal surveys of 286 participants, in outdoor programs, Kellert (1998) found:

> *The results of this research and other empirical inquiry lead us to conclude that prolonged and challenging immersion in the outdoors, especially in relatively pristine settings, can exert a powerful physical, emotional, intellectual, and moral-spiritual influence on young people.*

Taylor and Kuo (2009) found that children with ADHD concentrated substantially better after the walk in the park than after walks in urban areas, concluding *""Doses of nature" might serve as a safe, inexpensive, widely accessible new tool in the tool kit for managing ADHD symptoms"*.


2. NATURAL DE-STRESSING
AND RESTORATION

2. NATURAL DE-STRESSING AND RESTORATION

Recreation in natural areas provides an opportunity to escape the pressures of everyday life and allow for contemplation. There is now a large body of evidence that proves exposure to natural environments is effective in improving mood and reducing stress, thereby overcoming mental fatigue and restoring attentional capacity (Table 1). This is reflected both in psychological and physiological responses. As noted by Berto (2014):

> *Exposure to natural scenes mediates the negative effects of stress reducing the negative mood state and above all enhancing positive emotions. Moreover, one can recover the decrease of cognitive performance associated with stress, especially reflected in attention tasks, through the salutary effect of viewing nature*.

Ulrich *et. al.* (1991) consider that stress is the process by which an individual responds psychologically, physiologically and behaviourally to a situation that challenges or threatens their well-being, noting:

> *The psychological component includes cognitive appraisal of the situation, emotions such as fear, anger, and sadness, and coping responses. The physiological aspect consists of activity responses in numerous bodily systems, such as the cardiovascular, skeletomuscular and neuroendocrine, that mobilize the individual for coping or dealing with the situation. This mobilization uses resources or energy and, if prolonged, contributes to fatigue. The behavioral component includes a wide range of manifestations for instance, avoidance, alcohol or cigarette use, and declines in cognitive performance on tasks such as proofreading (e.g. Cohen et aL, 1986). Also, after cessation of a stressor, after-effects may be observed such as a decline in frustration tolerance and lower task performance (e.g. Glass & Singer, 1972).*

The perceived psychological improvements induced by exposure to nature have been confirmed by numerous studies (Table 1) that have identified physiological changes indicative of reduced stress (i.e., decreases in blood pressure, pulse rates, cortisol, salivary amylase and adrenaline). For example Lee *et. al.* (2012) summarise results from their range of physiological assessments:

> *All indices were generally in excellent agreement. They imply that the forest environment has relaxing and stress-relieving effects on humans. The results also accord with the belief of many people–that forest environments enhance physical relaxation ... In our study, while people watched forest landscapes or walked around in the forest, their pulse rate, blood pressure, and cortisol concentration decreased. This supports the idea that the forest environment affects both the main components of the stress response system*.

Tsunetsugu *et. al.* (2007) considered that the physiological responses they identified *"suggest that sympathetic nervous activity was suppressed and parasympathetic nervous activity was enhanced in the forest area",* indicators of improved cognitive function.

The benefits of nature experiences have been found to be particularly significant for those with stress problems. Morita *et. al.* (2006) found "*those feeling chronically stressed gaining more beneficial effects*". In an American study Berman *et. al.* (2012) compared the effects that a walk in a park had on people suffering depression, compared to a walk in an urban area, finding participants exhibited significant increases in memory span and improvements in mood after the nature walk relative to the urban walk.

Cognitive functions are higher order mental processes that help us gather and process information. Numerous studies have found that exposure to natural environments have a restorative effect on improving cognitive functioning (Table 1). For example Berman *et. al.* (2008) concluded "*we have shown that simple and brief interactions with nature can produce marked increases in cognitive control. To consider the availability of nature as merely an amenity fails to recognize the vital importance of nature in effective cognitive functioning*".

The types of natural settings that have been found to enhance well-being include not only wild natural environments, such as forests, mountains, and sea-sides, but also semi-natural environments within cities, such as parks and gardens. Though not all environments have the same affect, as noted by Shin *et. al.* (2010) "*different forest settings may provide very different specific psychological outcomes*".

Takayama (2008) compared the effects of oldgrowth forests compared to a plantation, finding that "*subjects considered the old-growth forests with huge trees as more sacred, more comfortable, more serene and more natural than the control forest. Moreover, in the control forest there was no difference in any of the indicators used in the survey, while in the old-growth forests the therapeutic effect was confirmed by several indicators*"

In a study of urban greenspaces, Fuller et. al. (2007) found that "*degree of psychological benefit was positively related to species richness of plants and to a lesser extent of birds, both taxa where perceived richness corresponded with sampled richness*". Carrus *et. al.* (2015) similarly found "*the level of biodiversity and peri-urban location positively affect self-reported benefits, well-being and perceived restorativeness*"

The restorative effect of forests can, to some extent, be attainted just by viewing them from a distance, or even in a photograph or painting (Ulrich 1984, Ulrich *et. al.* 1991, Tennessen and Cimprich 1995, Laumann *et. al.* 2001, Berto 2005, Velarde *et. al.* 2007, Berman *et. al.* 2008, Weinstein *et. al.* 2009, Kjellgren and Buhrkall 2010, Lee *et. al.* 2012, Zelenski *et. al.* 2015, Ashley *et. al.* 2015). Velarde *et. al.* (2007) comment "*A significant part of the satisfaction derived from nature does not require being in the natural setting, but rather having a view of it*".

For example Lee et. al. (2012) found that changes elicited by viewing pictures of nature "*were very similar among all subjects, as reflected by subdued activity in the cerebral prefrontal cortex and the autonomic nervous system and reduced blood pressure*". The only exception was when the volunteers were physically excited by seeing cherry trees in full bloom.

Ulrich (1984) compared the recovery from surgery of patients with a view of a stand of trees compared to a view of a brick wall, finding "*the patients with the tree view had shorter postoperative hospital stays, had fewer negative evaluative comments from nurses, took fewer moderate and strong analgesic doses, and had slightly lower scores for minor postsurgical complications*".

Modified natural landscapes and virtual environments are generally less effective than real forests (Laumann *et. al.* 2001, Mayer *et. al.* 2009, Kjellgren and Buhrkall 2010). Mayer *et. al.* (2009) found that exposure to virtual nature had beneficial affects but that "*exposure to real nature was associated with greater psychological benefits than with virtual nature. Thus,*

taking a walk in the woods is not equivalent to watching a nature film if one is interested in accruing the greatest psychological benefit for either oneself or another".

Kjellgren and Buhrkall (2010) similarly found:

> *The natural environment yielded a significantly higher rating of degree of altered states of consciousness (ASC) and energy than the simulated natural environment. The results suggest that both environments facilitated stress reduction, with the natural environment additionally bringing increased energy and ASC, thus possibly enhancing and promoting restoration.*

The restorative effect is not limited to visual responses as real environments are much more complex, involving the senses of sight, hearing, touch, and smell.. Lee *et. al.* (2012) asked subjects to listen to various sounds from the forest, ranging from the noise of a stream to the singing of nightingales and other birds, with their eyes closed, observing "*subdued activity in the prefrontal cortex and the sympathetic nervous system, indicators of the physiological effects of exposure to these sounds. However, subjects who imagined being in the forest during the experiment showed more signs of relaxation, while those who did not have much interest in the sound or who associated the sound of the forest stream with the flushing sound of a toilet exhibited no objective relaxation effects*".

Zhang *et. al.* (2017) mentally fatigued their subjects and then assessed restoration in environments with similar visual surroundings but with different sounds present, finding that urban natural environments, with natural sounds, have a positive effect on the restoration of an individuals' attention and that natural sounds enhanced the pleasant mood and produced a positive enhancing effect on the restoration of attention and psychology.

It is interesting that effects can be generated by just thinking about a forest. Arriving at a forest has been found to have calming effects, even before recreating. For their assessment of people's responses Morita *et. al.* (2006) found duration of stay in the forest did not affect the outcomes and a positive effect was reported for most emotions simply on reaching the forest.

Even the anticipation of going to a forest can have physiological effects, Park *et. al.* (2007) found the cerebral activity and salivary cortisol of the subjects who were scheduled to go to the forest area was significantly lower than that of the subjects scheduled to go to the city area.

There has been considerable conjecture as to the mechanisms by which nature triggers positive changes in psychological states, physiological systems, behaviours and cognitive functioning (i.e. Wilson 1984, Ulrich *et. al.* 1991, Kaplan 1995, Mayer *et. al.* 2009, Shin *et. al.* 2010). Restorative experiences and environments have been postulated as the mechanism (i.e. Kaplan 1995). Restoration refers to positive changes in psychological states, physiological systems, behaviours and cognitive functioning.

The effect that exposure to natural environments have on overcoming mental fatigue and restoring attentional capacity has been extensively assessed with a variety of mechanisms proposed, including "involuntary attention" which is the fascination that "*comes into play when, out of interest, curiosity, and the like, certain objects (e.g. animals) and processes (e.g. exploration) capture and hold the attention"* (Hartig *et. al.* 1991) and a "*positive affect*

through predispositions to respond positively to surroundings conductive to well-being or survival" (Hartig *et. al.* 1991).

Berto (2005) considers "*attentional capacity can be renewed in natural environments because natural environments are innately fascinating: they evoke a type of effortless attention or fascination, that allows directed attention to rest and restore*".


3. FOREST AIR-BATHING

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The effect of a walk in the forest is not limited to the awakening of our primal instincts and psychological influences, there is growing evidence that what we breathe in affects us physically. Forest air-bathing (“Shinrin-yoku”) has been promoted since 1982 in Japan as a relaxation and/or stress management activity. It focuses on what is encountered during the breathing in of the components emitted from the forest.

Forests affect the environment within them by moderating temperatures and humidity which affects people's physiological and psychological responses. More significantly forests influence the quality and composition of the air within them, removing chemical pollutants and dust, generating oxygen, while adding a plethora biological particulate matter and their own chemical cocktails (Mao *et. al.* 2012).

Trees directly improve the quality of the air by removing gaseous pollutants and heavy metals from the air and trapping airborne dust and particles on leaves, branches and trunks (Beckett et. al. 2000, Rao et. al. 2004, Gupta et. al. 2008, Mao *et. al.* 2012, Lee and Lee 2014, Allahabadi *et. al.* 2017). Trees have been reported (Abbasi and Khan 2000) to remove air pollutants like hydrogen fluoride, some compounds of photochemical reactions and heavy metals like mercury and lead, and change some air pollutants to harmless metabolites through various physiological processes.

Forests also release large quantities of biological material into the air, such as pollen grains, fungal spores, microbes, bacteria, plant fragments, and phytoncides. These do not necessarily always have beneficial effects as some people can have allergic responses to air-born particles. Dust mites and grasses are the most common air-borne allergens, though some tree pollens can also provoke allergic reactions (Loureiro *et. al.* 2005).

Research has identified three major inhaled factors that can make us feel healthier. These factors are beneficial microbes, negatively-charged ions and phytoncides.

It is believed that exposure to airborne microbes in natural environments are important in developing effective immune systems (Rook 2013, Craig *et. al.* 2016). There are massive numbers (i.e. 10^5-10^6 per m^3) and varieties of microbes in the air of natural environments derived from the soil, plants and animals. The environment plays an important role in the formation and maintenance of our microbiota.

People living close to agricultural land have more biodiverse microbial populations on their skin than those living close to urban centers, and this correlates with immunoregulatory differences and reduced allergic diseases (Rook 2013). Craig *et. al.* (2016) state that "*external environmental (including airborne) microbiota can bring about feelings of pleasure and change our mental and physical health for the better".* Rook (2013) considers that reduced exposure to immunoregulation-inducing 'Old Friends' from our evolutionary past can lead to susceptibility to chronic inflammatory diseases, cardiovascular disease, and some forms of inflammation associated depression. Rook (2013) summarises:

> *... the illnesses that are increasing in high-income countries are associated with failing immunoregulation and poorly regulated inflammatory responses, manifested as chronically raised C-reactive protein and proinflammatory cytokines. This failure of immunoregulation is partly attributable to a lack of exposure to organisms (“Old*

> *Friends") from mankind's evolutionary past that needed to be tolerated and therefore evolved roles in driving immunoregulatory mechanisms. Some Old Friends (such as helminths and infections picked up at birth that established carrier states) are almost eliminated from the urban environment. This increases our dependence on Old Friends derived from our mothers, other people, animals, and the environment. It is suggested that the requirement for microbial input from the environment to drive immunoregulation is a major component of the beneficial effect of green space, and a neglected ecosystem service that is essential for our well-being*

The air around us contains both positive and negative ions in roughly equal number. It is considered that negative ions may actually be beneficial to our health, while positive ions may be detrimental. These ions are created when air molecules are ionised by cosmic radiation and terrestrial radiation from the trace gas radon and its daughter products.

Increased negative ions are associated with water and forests. Forests have been found to have 2 to 4 times as many cluster ion concentrations as non-forests (Jayaratne *et. al.* 2011). Groundwater is particularly rich in radon. Groundwater that is brought up to the surface by deep-rooted trees and released into the atmosphere during transpiration may contain radon and contribute to the increase in negative ions (Jayaratne *et. al.* 2011).

The health benefits of negative ions have long been promoted, while a variety of studies have identified beneficial effects of negative ions others have been equivocal. Baron (1987) found "*negative ions can affect performance on tasks involving several different aspects of cognitive functioning*", warning *"such effects appear to be quite complex in scope, and far from uniformly beneficial in nature".* In similar studies Goel and Etwaroo (2006) found that high concentrations of negative ions "*improve mood acutely in a student sample, including a subset with depressive symptoms*", and Flory *et. al.* (2010) found that high concentrations of negative ions "*are effective antidepressants for treating [Seasonal Affective Disorder] in women*".

From a literature review Perez *et. al.* (2013) concluded that "*No consistent influence of positive or negative air ionization on anxiety, mood, relaxation, sleep, and personal comfort measures was observed. Negative air ionization was associated with lower depression scores particularly at the highest exposure level"*. It would seem that, to varying extents, negative ions are likely to make some contribution to the beneficial effects of forests on people.

Phytoncides are defined as volatile or nonvolatile substances produced by all types of plants that have an influence on other organisms (Tsunetsugu *et. al.* 2010). These include organic compounds such as a-pinene, limonene and eucalyptol. In Japan it was found that more than 100 different types of phytoncides can be detected in the air in forests (Lee *et. al.* 2012). Concentrations of phytoncides in forests are very low and vary depending on many factors, such as season, climate, and species composition (Tsunetsugu *et. al.* 2010).

Just like essential oils have been shown to have antioxidant, anti-inflammatory, and anti-microbial effects, so their aromas also seem to have healthful effects on the human body and mind. We breathe in the chemicals released by these oils as we walk among the trees, taking in their protective benefits. Li (2010) regards forest bathing as a form of natural aromatherapy. As noted by Tsunetsugu *et. al.* (2010) "*Smell has commonly been considered*

to be associated with instinct, emotion, and preference, and to have a greater influence on physiological change than stimuli for other senses".

Phytoncides have been found to lower blood pressure in rats (Kwakami *et. al.* 2004), provide relaxing and stress-relieving effects on mice (Cheng *et. al.* 2009), and elevate feed efficiency, nutrient digestibility, and improve the fecal *Lactobacillus* counts in weaning pigs (Zhang *et. al.* 2012).

In their 6 year study Ohtsuka *et. al.* (1998) found that after shinrin-yoku the blood glucose level decreased by an average of 39.7%, considering that "*In addition to the energy consumption caused by walking itself, the so-called phytoncides are thought to be related to the decreased blood glucose levels ... It is assumed that the large number of negative ions in a forest environment is another cause of the decrement in blood glucose levels*".

Li (2010) cites a variety of studies that show the citrus fragrance found in forests affected human endocrine and immune systems, and that the essential oil from *Pinus mugo* showed antioxidative properties..

In a controlled setting Nam and Uhm (2008) found that inhalation of pine and cypress phytoncides 3 times a day significantly decreased systolic and diastolic blood pressure, and serum cortisol levels in young adults. In response to a stressor, the excretion of cortisol, blood pressure, and pulse rate generally increases.

In a controlled setting Kim *et. al.* (2012) assessed the effects of phytoncide aromatherapy on nursing students, concluding "*it can be suggested that phytoncide aromatherapy was effective in decreasing stress and peripheral manifestations of stress and changing in* [Heart Rate Varability]"

D-limonene is one of the most common volatile organic compounds in nature, being a major constituent in several pine and citrus oils. In a controlled setting Joung *et. al.* (2014) found that olfactory stimulation with D-Limonene induced (1) a significant increase in parasympathetic nervous activities, (2) a significant decrease in the heart rate, and (3) a significant increase in a “comfortable” feeling.

In a controlled interior setting, Lee *et. al.* (2012) found statistically significant reductions in systolic blood pressure after inhalation of a-pinene and limonene. They also found that systolic blood pressure decreased significantly and brain activity was significantly subdued after inhalation of fragrances produced by the wood chips of *sugi* (*Cryptomeria japonica*) and *hiba* (*Thujopsis dolabrata*).

From their outdoor study Lee and Lee (2014) found that "*walking in a forest environment, in contrast to walking in a city, reduces arterial stiffness and increases pulmonary function in Korean elderly women*". They concluded that due to the presence of phytoncides, the "*anti-oxidant and anti-inflammatory properties of forest environments may therefore have a protective effect on both vascular and pulmonary function*". Though also recognised that the results could also be due to increasing parasympathetic nervous system activity and/or reduced air pollution.

In the last 30 years, some 45% of all new anticancer drugs have been derived directly or indirectly from plant-based natural products (Vuong *et. al.* 2015).

The immune system, including natural killer (NK) cells, plays an important role in the defence against bacteria, viruses and tumors. It has been reported that NK cells kill tumor or virus-infected cells by the release of anti-cancer proteins *("perforin, granzymes, and GRN via the granule exocytosis pathway")* (Li and Kawada 2010)

Li (2010) cites in vitro studies where a mixture of phytoncides was found to significantly enhance human NK activity and anti-cancer proteins. A series of studies examined NK activity from blood and urine analyses during and after recreation in forests and urban areas, as an indicator of immune function and anticancer activity (Li 2010, Li and Kawada 2010, Lee *et. al.* 2012, Kim et. al. 2015). Lee *et. al.* (2012) reported:

> *After the second day walk in the local forest, NK activity was enhanced by 56% in these subjects, and normal immune functions were restored. A statistically significant increase of 23% was maintained for 1 month even after these volunteers had returned to urban life, clearly illustrating the preventive medical effect of nature therapy*

Li and Kawada (2010) report on a variety of similar studies of trips of 1-3 days to forest parks that resulted in increased NK activity, number of NK cells, and levels of intracellular anti-cancer proteins. Li and Kawada (2010) conclude "*Phytoncides released from trees and decreased stress hormone levels may partially contribute to the increased NK activity*".

The concentrations of adrenaline and noradrenaline in urine have been used to evaluate work related stress in which the subjects showed decreases in adrenaline and/or noradrenaline in urine with lower stress (Li and Kawada 2010). It has been found that forest bathing trips significantly decreased adrenaline and noradrenaline concentrations in urine (Li and Kawada 2010). Li and Kawada (2010) consider "*The increase in NK activity during forest bathing trips may be related to an attenuated stress hormone response (adrenaline) associated with the forest bathing trip*". They also identify that in-vitro exposure to phytoncides has significantly decreased the concentrations of adrenaline and noradrenaline in urine.

Li and Kawada (2010) report on another of their studies which "*found that people living in areas with lower forest coverage had significantly higher standardized mortality ratios for cancers compared with the people living in areas with higher forest coverage in Japan, suggesting that forest environments may partially contribute to decreased mortality ratios for some cancers (Li et al. 2008c)*".

Lee *et. al.* (2012) summarise *"Taken together, these findings indicate that forest visits increase NK activity … Phytoncides released from trees as well as decreased production of stress hormones may also partially contribute to this increased NK activity ... Because NK cells can kill tumor cells by releasing anti-cancer proteins ... and forest visits increase NK activity and intracellular levels of anticancer proteins, we can conclude that forest visits may have a preventive effect on cancer cell generation and development*".

Eucalypts

As exemplified by eucalypts, there are numerous plant species in Australian forests that contain bioactive phytoncides that are released into the air and are likely to have similar health benefits as phytoncides found in the northern hemisphere.

The genus *Eucalyptus,* and the related genera of *Angophora* and *Corymbia*, are native to Australia and contain over 700 species. Eucalyptus contains high levels of volatile organic compounds (VOC) many of which possess antiseptic properties. The major component found in Eucalyptus oil is the monoterpene ether 1,8-cineole, otherwise known as eucalyptol, which accounts for more than 70% of the oil mass and has been linked to antibacterial, anti-inflammatory, and anticancer effects (Vuong *et. al.* 2015), though other VOC (i.e. a-pinene, terpinen-4-ol, and g-terpinene) are important contributors to health effects. More than 20 individual nonvolatile compounds have been isolated from various Eucalyptus species, with phenolic compounds the major compounds, variously contributing to antioxidant effects, strengthening of the immune system, reducing the risk of diabetes, obesity, and cardiovascular diseases (Vuong *et. al.* 2015). Oil contents varying widely between species, individuals, parts of the plants, seasons and locations (Vuong *et. al.* 2015).

Eucalyptus leaves have been traditionally used by Aborigines to treat flu, colds, and fever, alleviate internal pain and headaches, as an antiseptic, to treat wounds, for toothache, and in various ways during childbirth (Vuong *et. al.* 2015).

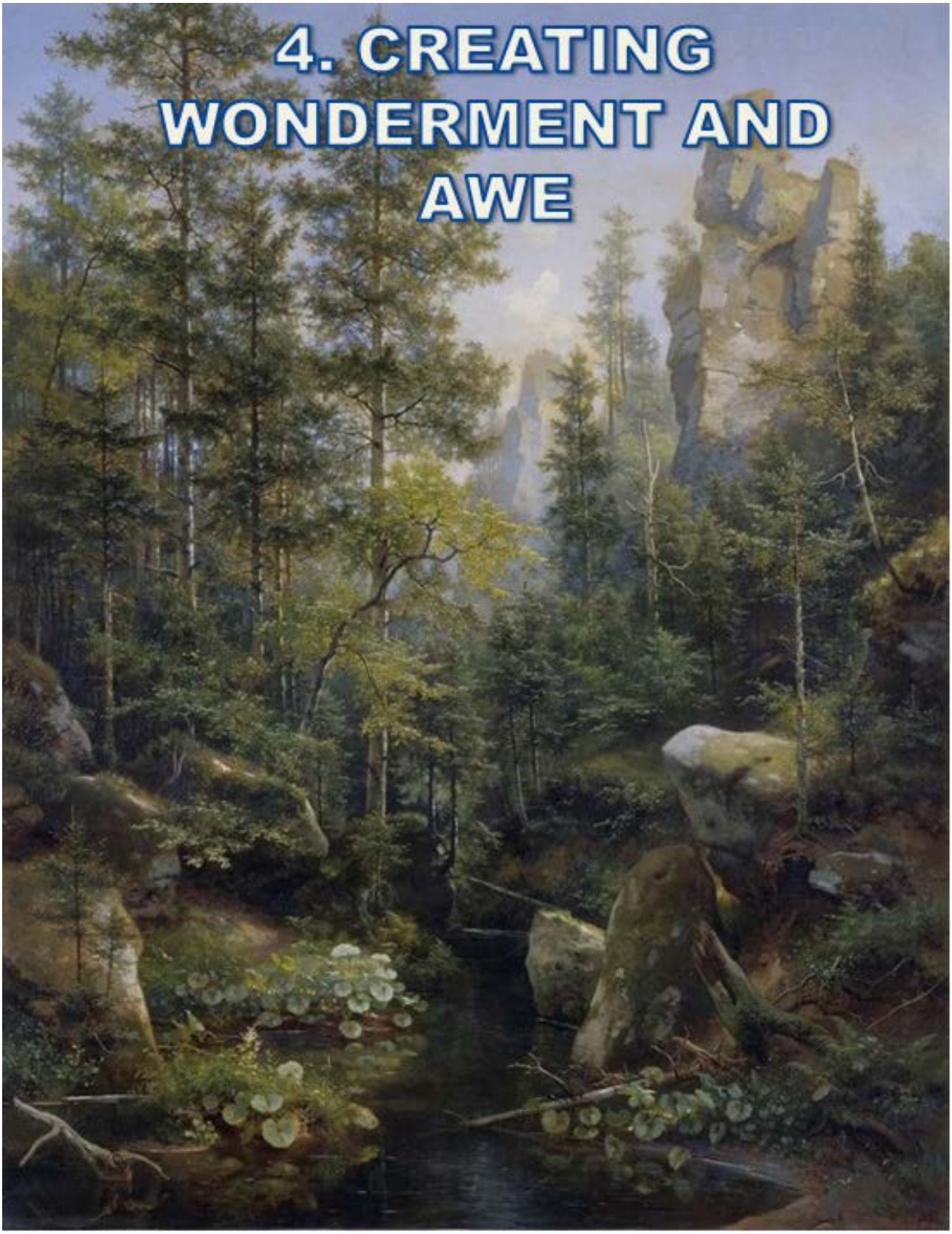
About twenty eucalypt species are currently being exploited commercially worldwide for their medicinal and pharmaceutical properties, as well as for food additives (Bhuyan *et. al.* 2017), though research has confirmed essential oils and extracts from a variety of other eucalypts as possessing numerous bioactive components that have antibacterial, anti-inflammatory, antioxidant, antifungal and anticancer properties (Vuong et. al. 2015).

In vitro studies have found numerous volatile and nonvolatile compounds derived from a variety of eucalypts have inhibitory effects on a range of cancer cells (i.e. Ashour 2008, Singab 2011, Bhagat et. al. 2012, Doll-Boscardin et. al. 2012, Hrubik *et. al.* 2012, Tian *et. al.* 2012, Soliman 2014, Vuong *et. al.* 2015, Vuong et. al. 2015b, Bhuyan *et. al.* 2017, Bhuyan *et. al.* 2017b).

Eucalyptus (and related genera) that have been found to have anti-cancer properties include *Angophora floribunda* (Bhuyan *et. al.* 2017), *Angophora hispida* (Bhuyan *et. al.* 2017), *Corymbia citriodora* (Bhagat *et. al.* 2012), *Eucalyptus benthamii* (Doll-Boscardin et. al. 2012), *Eucalyptus camaldulensis* (Singab 2011, Hrubik *et. al.* 2012), *Eucalyptus cinerea (*Soliman 2014), *Eucalyptus maideni* (Tian *et. al.* 2012), *Eucalyptus microcorys* (Bhuyan *et. al.* 2017b), *Eucalyptus robusta* (Vuong et. al. 2015b), *Eucalyptus sideroxylon* (Ashour 2008), and *Eucalyptus torquata* (Ashour 2008),

Extracts of several Eucalyptus (and related genera) such as *E. globulus, E. camaldulensis, Corymbia citriodora*, *E. grandis, E. incrassata, E. maidenii,* and *E. torquata* identified anticancer activity against a range of cancer-cell lines both in vitro and in vivo (Takasaki *et. al.* 1995, Bhagat *et. al.* 2012, Vuong *et. al.* 2015). For example in vivo tests on mice found compounds from *E. grandis* and *E. incrassata* "*exhibited remarkable anti-tumor-promoting*" effects (Takasaki *et. al.* 1995) and *Corymbia citriodora* "*highly significant effects*" on tumors (Bhagat *et. al.* 2012).

There is a high likelihood that phytoncides from eucalypts, and other native plants, contribute to the stress reduction, rejuvination, and health benefits of recreating in Australian forests.



Waldeinsamkeit, Eduard Leonhardi (1887).

4. CREATING WONDERMENT AND AWE

Natural environments can invoke wonder and awe, whether it is an ancient giant tree, an unusual encounter with an animal, an impressive waterfall, a spectacular view or immersion in a wilderness remote from civilisation. Such encounters can create deep emotional and spiritual experiences. Shin *et. al.* (2010) consider

> *When a person is in a forest environment, he or she may possibly be subjected to ‘‘forest stimuli’’ or be struck by the greatness and mystery of the forest. When in a state of ‘‘flow’’, he or she may forget about society and, by means of communing with nature in the forest, possibly reach a state of inner peace and serenity, that may resemble some states experienced during a religious experience.*

Transcendent or spiritual episodes have a special association with nature, with forests an important setting and source for mythical and religious rites and stories (Williams and Harvey 2001). The Germans use the word "waldeinsamkeit" to refer to the positive feeling of being alone in the woods, while also indicating a connectedness to nature, often with spiritual or magical overtones. Waldeinsamkeit was a focus of the German Romanticism movement (1800-1850) which was centered on returning to nature and becoming a part of untamed nature.

Transcendent or spiritual episodes can be described (Williams and Harvey 2001) as:

> *"A moment of extreme happiness; a feeling of lightness and freedom; a sense of harmony with the whole world; moments which are totally absorbing and which feel important"*

From their experiments Rudd *et.al.* (2012) concluded that awe’s ability to alter the subjective experience of time led people to feel they had more time available, be less impatient, be more willing to volunteer their time to help other people, more strongly prefer experiences over material products and experience greater life satisfaction. Leading them to conclude:

> *Experiences of awe bring people into the present moment, and being in the present moment underlies awe’s capacity to adjust time perception, influence decisions, and make life feel more satisfying than it would otherwise.*

Fredrickson and Anderson (1999) identify that 'peak' and 'flow' experiences "*are marked by a momentary loss of sense-of-self, where the usual subject/object distinctions break down and the individual becomes totally immersed in the present moment; leading to a more self-actualized state of existence when experienced on a frequent basis*".

Ashley *et. al.* (2015) defines spiritual as *"human’s relationship with what moves him most deeply, with what he holds dear. This often is something that is larger than him/herself that transcends his/her isolated sense of self and is often considered as meaningful in some ultimate way".*

Williams and Harvey (2001) assessed reported transcendent experiences in forests, identifying at least two distinct forms; one characterized by strong feelings of insignificance and one characterized by a strong sense of compatibility and familiarity. They found evidence of close relationships between transcendence and both aesthetic and restorative functions of nature, also considering that fascination may assist in accounting for transcendent as well as restorative experiences in nature.

Opportunities to see wildlife behaving naturally are an important component of people's desire to visit natural areas (Bath and Enck 2003, Moscardo and Saltzer 2004, Ballantyne *et. al.* 2011, Curtin and Kragh 2014), The effect of the experience depends upon the person involved, the appeal of the species seen, the closeness of the encounter, the perceived rarity of the species and its behaviour, and the level of interaction (DeMares and Krycka 1998, Bath and Enck 2003, Ballantyne *et. al.* 2011). Ballantyne *et. al.* (2011) consider "*In the context of wildlife tourism, experiencing a sense of wonder, awe, excitement and privilege appeared to contribute to visitors' emotional arousal, thus producing vivid and enduring memories*".

DeMares and Krycka (1998) reviewed 7 peak (spiritual/transcendent) wildlife encounters with marine mammals, finding "*that a significant experience with a dolphin or whale can arouse in the human participant a sense of harmony, connectedness, and aliveness. The subjects who experienced such an animal-triggered peak also perceived deliberate intention and direct eye contact with the animals"*. Contact with potentially dangerous animals can heighten the experience, as related for one woman's encounter with a Killer Whale: "*The fulfillment of her life's dream, and the feelings of incredulity and excitement which followed, were intensified by the adrenaline surge which she was feeling due to the proximity of the animal and her exposure".*

Wildlife interactions feature in many other peak experiences, including viewing rare and unusual activities such as watching the birth of a Kangaroo in the wild (Williams and Harvey 2001).

Heavily mediated and controlled wildlife experiences "*can lack the intimacies that provoke emotional and potentially lifelong affiliations with the natural world*" (Curtin and Kragh 2014).

It needs to be recognised that while wildlife experiences can be beneficial to humans, they are rarely beneficial to wildlife, with frequent detrimental impacts (Bath and Enck 2003, Ballantyne *et. al.* 2011, Curtin and Kragh 2014). Though it is also important to recognise that wildlife encounters can foster empathy and concern for their conservation, as noted by Curtin and Kragh (2014); "*Our gift to habitats and wildlife today is to encourage people to engage with them, to empathize with the plight of disappearing species and habitats and to acknowledge their importance and their intrinsic value to the future of humankind*".

Immersion in natural places remote from everday life can have intensified effects, most obviously when it is for prolonged periods There has been particular focus on the effect of wilderness on people's emotional state and spirituality (Talbot and Kaplan 1986, Hartig *et. al.* 1991, Fredrickson and Anderson 1999, Heintzman 2006, Foster and Borrie 2011, Heintzman 2012, Ashley *et. al.* 2015). Hartig *et. al.* (1991) found that prolonged wilderness experience has restorative effects. From their respondents Foster and Borrie (2011) found the "*vast majority stressed the mental calm and self-reflective thinking brought on by wilderness*". Heintzman (2006) found that a "*sense of peacefulness*" encapsulated the immediate impact of participation in the wilderness canoe trip.

Foster and Borrie (2011) consider:

> *In wilderness, social constraints and expectations are minimized, cultural information to be processed is limited, primitive ways of being are practiced, and raw encounters with the natural world are lived. In these conditions, the human relationship with the wild is often kindled, stoked, and/or sustained.*

A sense of spirituality has been associated with being removed from everyday life and being in an awe-inspiring environment (Kellert 1998, Fredrickson and Anderson 1999, Heintzman 2006, McDonald *et. al.* 2009, Heintzman 2012, Ashley *et. al.* 2015). Heintzman (2012) summarises:

> *Spiritual experience in wilderness has been characterized by emotions of awe and wonderment at nature, feelings of connectedness, heightened senses, inner calm, joy, inner peace, inner happiness, and elatedness (Fox 1997); intense and often positive emotions (Stringer and McAvoy 1992); peacefulness, including peace with oneself and the world (Heintzman 2007); and religious-like or self-transcending feelings of peace and humility (Fredrickson and Anderson 1999).*

Fredrickson and Anderson (1999) found that during recreation in wildernesses many participants felt far removed from modern civilisation and "*experienced a heightened sensitivity toward the sights and sounds that were immediately surrounding them"*, and "*it was the wild and untamed aspects of the wilderness environment that spoke to most participants at a very deep level, and left them open to perceiving the place as more of a transcendent reality"*, noting "*Participants spoke of the expansiveness of the landscape and an awareness of the sheer powers of nature as contributing to a meaningful wilderness experience, which thereby acted as spiritual inspiration for most individuals*".

From questioning people about their peak experiences in wildernesses, McDonald *et. al.* (2009) identify "*The most commonly cited objects of attention at the time of the participants' peak experiences were sunlight (particularly late afternoon sunsets), forests, mountains, wild animals, and valleys*", with the experience involving "*feelings of merging with or being at one with the wilderness, world, or universe*" , and:

> *The most commonly cited qualities included tranquility (silence, the gentle sounds of nature, lack of human activity), the absence of time constraints and crowds (affording a level of freedom not possible in a human-made environment), the opportunity for solitude, reflection and contemplation, observing subtle shifts in the weather, and the sighting of wild animals in their native habitat.*

McDonald *et. al.* (2009) conclude that "*It was found that in wilderness the participant's experienced a unique combination of aesthetic pleasure and renewal that can lead the triggering of peak experiences*".

From showing people photographs of Tasmanian wilderness Ashley *et. al.* (2015) found *"the variables beautiful, natural, remote, quiet, and peaceful most reflected the spiritual content of the images. Images that most consistently evoked a spiritual response by respondents commonly contained ephemeral components such as clouds, waters reflections, waves and mist and a special quality of light such as mountain glow and light filtered through trees".*

From his survey of people using the Tasmanian wilderness Ashley *et. al.* (2015) identified the defining characteristics of wilderness spirituality, from most to least common, as:

- *Feelings of inner peace and tranquility contributing to personal contentment*
- *Physical, mental and emotional refreshment thereby life enhancing*
- *Connection and relationship with nature and increased understanding taking one beyond or outside the self*
- *Feelings of awe and wonder about nature and life*
- *Feelings of happiness and inspiration*

- *A respect for and valuing of nature contributing to a change in personal values*
- *A feeling of humility and self-forgetting resulting in ego detachment*
- *A religious meaning and explanation may be present*
- *A heightened sense of awareness and elevated consciousness beyond the everyday and corporeal world conducive to possible transcendent experiences*
- *Motivation to protect and sustain wilderness areas inducing a sense of personal responsibility for their custodianship and stewardship*

From an analysis of the journals of participants undertaking the Outdoor Challenge Program, Talbot and Kaplan (1986) found:

> *In time, daily functioning in these surroundings came to be accompanied by a strong sense of comfort--described not as physical ease but rather as an appreciation for the ease of fitting in with the wilderness environment. The participants' growing environmental awareness was often accompanied by similar increases in perceived levels of self-knowledge, and by sensations of awe in relation to the natural environment and the events observed there.*

From their retrospective surveys of 429 participants, and longitudinal surveys of 286 participants, in outdoor programs, Kellert (1998) found:

> *These sentiments of spirituality and humility toward nature prominently occurred among many program participants in both the longitudinal and retrospective studies. The wilderness experience was frequently cited as a powerful source of moral and spiritual inspiration, meaning, and significance. Many participants indicated increased faith and ethical commitment to protecting the environment stemming from their encounters with relatively unspoiled nature.*

Fredrickson and Anderson (1999) found that "*most participants were definitely moved to new spiritual heights as a result of their wilderness experience*", concluding "*this study does indicate that recreational experiences in a wilderness setting have the distinct potential to positively enrich the lives of those who take to the 'wild'. The beneficial aspects of wilderness recreation include not only the potential for physical and emotional growth, but moreover the opportunity to grow spiritually*".

From responses of participants in the Outdoor Challenge Program, Talbot and Kaplan (1986) found:

> *... when asked if they felt these experiences had changed them, many of the participants reflected a sense that they wanted to live life more simply and slowly in the future because of these experiences (to 'look more closely, take my time', to 'consume less, and simplify'). Many also felt a more compelling interest in the world of nature, and felt they would be more considerate of their family and friends ('just an opener and nicer person'). They also wanted to be careful to make decisions about their lives which reflected their own priorities rather than others' values ('a lot of things I thought were important really are not', I'm 'more determined to change what I don't like').*

Not all wilderness experiences are positive, as mundane chores, insects, swamps, rains and strenuous stretches have been identified as negative experiences (i.e. Talbot and Kaplan 1986).

Kellert (1998) emphasise that "*the notion of awe encompasses elements of fear as well as reverence and wonder*", with "*risk, danger, and uncertainty associated with challenging landscapes and species*" able to "*foster more positive sentiments of awe, humility, and respect for nature*". They found:

> *Most of the participants experienced fear and anxiety toward nature at some point in their programs. Most asserted nonetheless how much they benefited from learning to cope with these fears and apprehensions. Moreover, many acknowledged how much their respect and admiration for nature depended on coming to better appreciate the power and danger posed by particular natural systems and species.*

Some studies suggest spiritual experiences in wilderness have long-term influences on some people's lives, though this is not necessarily the case (Heintzman 2012, Rude *et. al.* 2017). Hartig *et. al.* (1991) found the "*greater happiness*" affects of recreation in a wilderness "*prevailed over a 3 week period*". From their small sample Heintzman (2006) considered "*the long-term impact of the wilderness experience seemed to be primarily positive memories and reflections on the experience rather than concrete lifestyle or behavioral changes*". Rude *et. al.* (2017) found that outdoor orientation fostered involvement in campus life, but that *" participants reported lower levels of spirituality".*

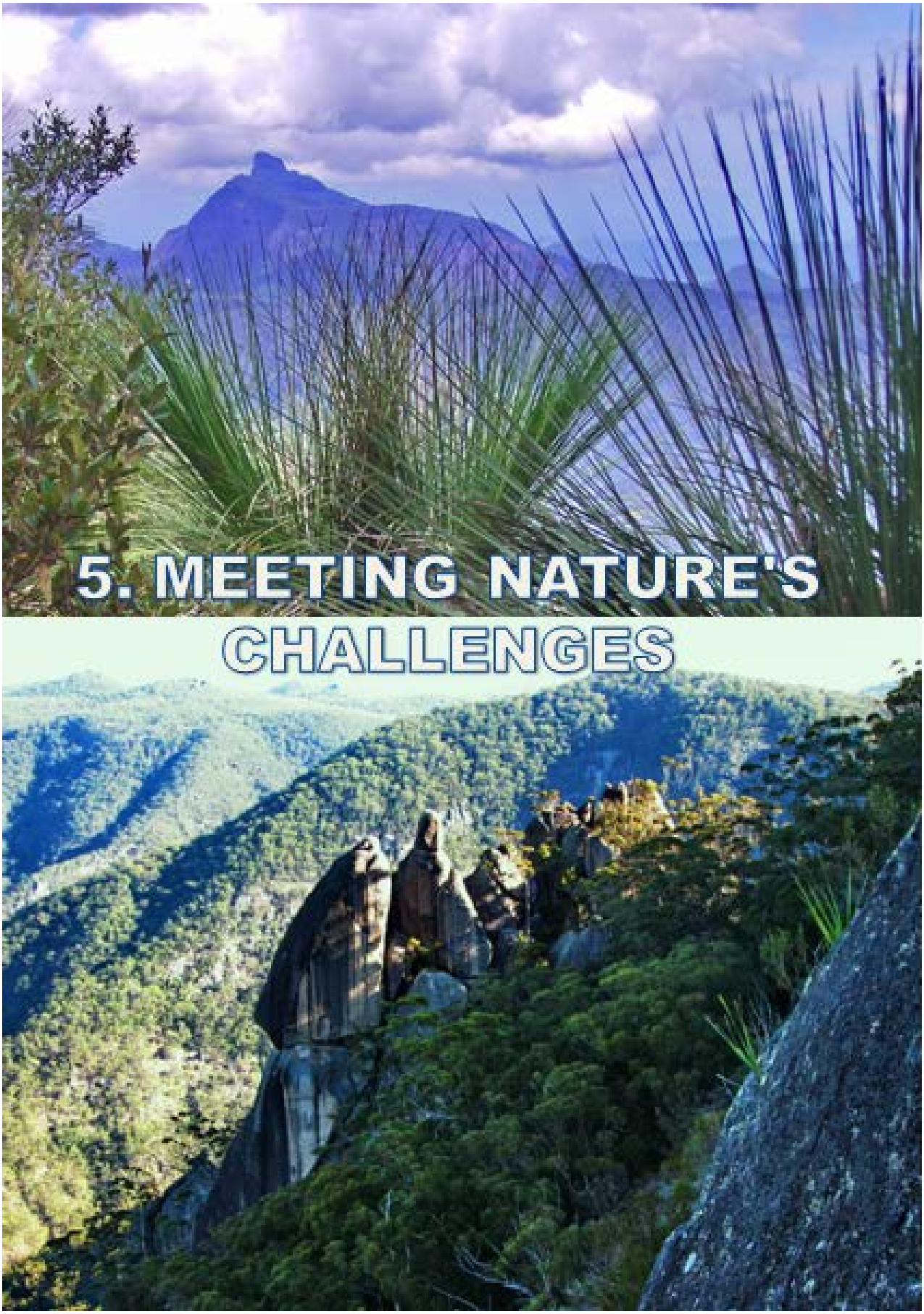
The differing perceptions of spiritual influences may be in part due to personalities and the nature of the activities being undertaken. Heintzman (2012) notes that spiritual benefits of wilderness are valued more by people involved in more nature-oriented activities such as walking, hiking, photography and bird-watching, as compared to people involved in physically challenging activities, such as adventure recreation.

Similarly Williams and Harvey (2001) found reported transcendent episodes in forests were rarely attributed to the activity undertaken in the forest, the majority of respondents attributing their experiences to qualities of the physical environment.

From their survey of participants 4 months after wildlife encounters, Ballantyne *et. al.* (2011) considered their "*research has clearly demonstrated the power of wildlife to evoke lasting memories and transformative experiences*", noting:

> *In the context of wildlife tourism, the emotional experience provoked deeper thought, leading to a concern and respect not only for the specific individuals encountered in the wildlife tourism experience, but the species as a whole. This was particularly the case when visitors could actually witness the animals' struggles to survive, or when the information provided by commentaries or signage focussed on the threats posed by human actions.*

DeMares and Krycka (1998) found that as a result of peak wildlife experiences "*for the human, there is a feeling of being permanently changed or enlightened by the experience. Immediate stress reduction is common, as well as the feeling of being able to call forth memories of the encounter at some future date for an emotional boost or to reduce stress.... The dynamics of the experience become a cherished life event ranked in the mind of the human participant as among life's most memorable experiences*".


5. MEETING NATURE'S
CHALLENGES

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Natural environments have been found to result in more co-operative behaviour, whether from a walk in the park (Gueguen and Stefan, 2014) watching videos (Zelenski *et. al.* 2015) or a hike through wilderness (Duvall and Kaplan 2013, Rude *et. al.* 2017).

Zelenski *et. al.* (2015) found that participants exposed to nature videos (in this case forest, flood, and wolf videos) responded more cooperatively on a measure of social value orientation and, when considering environmental problems as social dilemmas, increased sustainable intentions and behavior, commenting "*nature appeared to shift people's preferences from immediate gratification to larger but more distant payoffs*".

Weinstein *et. al.* (2009) hypothesise that "*when people are in contact with natural scenes or living objects they will demonstrate a more intrinsic value set, orienting them to greater connection and a focus on others*". Their experimentation using slides and plants led them to conclude "*Together these findings suggest that full contact with nature can have humanizing effects, fostering greater authenticity and connectedness and, in turn, other versus self-orientations that enhance valuing of and generosity toward others*".

The natural environment can provide many physical challenges, whether it is a child climbing a tree, an adult climbing a mountain, or a long-trek through wilderness. Risk, fear and uncertainty may be associated with particularly challenging events, mastery of which can result in "*a sense of deep accomplishment, which invariably bolstered their self-confidence and self-esteem*" (Fredrickson and Anderson 1999),.

Working together in a non-competitive environment, and shared experiences, can be significant contributors to the benefits of wilderness and adventure experiences (Kellert 1998, Fredrickson and Anderson 1999, Garst *et. al.* 2001, Heintzman 2006, Heintzman 2012, Duvall and Kaplan 2013, Rude *et. al.* 2017). Heintzman (2006) concluded that "*both sharing with others and solitude in nature are important to the participants' spiritual experience*". From their extensive surveys Kellert (1998) found:

> "*the friendship, affection, and allegiance expressed by participants toward one another and the natural environment were often among the most pronounced sentiments encountered. Previously total strangers developed extraordinary feelings of affection and loyalty for one another and the natural world in a relatively short period of time, and this bonding often remained strong long after the experienc*e".

Bunting *et. al.* (2000) observe:

> *Although any physical exertion challenge has elements of psychological stress, unless there is the possibility of psychological and social loss, the stress is primarily that of physical exertion. This has been demonstrated by numerous researchers of physical stress reporting significant increases in norepinephrine (the catecholamine most closely aligned with physical stress), with no increase in epinephrine (most indicative of psychological stress) (Frankenhauser, 1981; Williams, 1986).*

Just overcoming the physical and mental challenges of a long hike through wilderness can provide "*a powerful sense of achievement*" (i.e. McDonald *et. al.* 2009).

Adventure recreation in natural environments provides extreme challenges, it generally involves a deliberate seeking-out of real or perceived risk and danger (Ewert and Hollenhorst

1997, Paxton and McAvoy 2000), involving activities such as mountaineering, rock climbing, scuba diving. backcountry skiing/snowboarding, whitewater boating, rapids swimming, and caving. Adventure recreation has a suite of psychological and physiological effects related to the degree of activation, stimulus, risk and challenge associated with the activities undertaken.

Ewert and Hollenhorst (1997) consider that close proximity to danger tends to heighten concentration and adds consequence to individual decision making, with an uncertainty of outcome influenced by the skills and actions of the participant, potentially leading to extraordinary experiences.

Ewert (1987) identifies:

> *"A substantial research effort has been made linking outdoor adventuring as a form of therapy with goals such as enhanced self-concept, improved social attitudes and behaviour, improved physical health or reduced emotional problems"*

Bunting *et. al.* (2000) found:

> *The advanced rock climbing and advanced Whitewater canoeing days elicited the highest urinary neuroendocrine responses, and lower fit participants had higher neuroendocrine levels when compared to the higher fit participants*

Bunting *et. al.* (2000) consider that the combined physical and psychosocial challenge of outdoor adventure activities is an excellent form of active toughening or purposeful stress adaptation, citing theories that:

> *... periodic stimulation makes the SNS [sympathetic nervous system] more responsive and efficient during stress, without negatively affecting the immune system. The theorized toughening occurs from the conditioning of the physiological arousal responses and a sense of success and satisfaction from the exercise that has been viewed as a challenging experience rather than a distressing experience.*

Studies have found that engagement in adventure activities in wilderness can have long-term and life-changing effects on participants. From their extensive surveys of participants in outdoor programs, Kellert (1998) found:

> *The majority of respondents regarded their experience as one of the best in their life, and as having exerted major impacts on their personal and intellectual development as well as outdoor recreational and environmental interests. A smaller, but substantial minority, viewed the experience as significantly affecting their career interest and inclination to contribute community service.*

From their survey of participants in an outdoor program Paxton and McAvoy 2000) found "*self-efficacy levels increase during the 21-day wilderness course, but also they kept increasing, even up to six months after the course*". Self-efficacy "*refers to our beliefs about our ability to execute control over our own level of functioning and the events that affect our lives*".

From their assessment of the effects of wilderness trips on war veterans, Duvall and Kaplan (2013) found:

> *Results of this study indicate that participation in extended group outdoor recreation experiences may be associated with a number of significant benefits. Study participants reported significant improvements in psychological well-being, social*

> *functioning, and life outlook one week after the outdoor experience; there was also some indication that these improvements persisted over the next month. ... The changes in psychological well-being, social functioning, life outlook, and activity engagement were particularly strong for veterans who had initially reported more severe on-going health issues.*

Rude *et. al.* (2017) found that "*Participating in outdoor orientation appears to set in motion a propensity for students to become more involved in campus life, which fosters a greater sense of community, which then culminates in thriving*".

Adventure recreation has long been thought to alleviate negative behaviours among at risk youth, with the first American outdoor adventure programs specifically designed for disturbed youth commencing in the 1930s, and Outward Bound commencing in the United Kingdom in 1941 (West and Crompton 2001). The ultimate purpose of the Outward Bound program is to push participants to master seemingly impossible tasks so they experience a feeling of personal accomplishment and success (West and Crompton 2001).

West and Crompton (2001) reviewed studies into the use of recreation programs for the instrumental purpose of alleviating negative youth behaviour, and while identifying some methodological problems, found the studies "*convincing in suggesting that participants' self-concept is enhanced and that recidivism rates are lower for participants in outdoor adventure programs*". They note:

> *The results from studies evaluating recidivism rates tended to be positive, with eight out of 14 studies reporting reduced rates of recidivism in their treatment groups. Fourteen out of 16 studies investigating changes in the self-concept of participants also reported significant positive changes. The cumulative consistency of the findings adds credence to the notion that outdoor adventure programs can contribute to alleviating negative behaviors among youth.*

Garst *et. al.* (2001) identify that outdoor adventure programs may reduce negative youth behaviour by: (1) increasing participants' feelings of positive self-perception, (2) providing ways that adolescents can gain knowledge, skills, and abilities, or (3) increasing adolescents' understanding and knowledge of a positive peer culture and their ability to develop positive peer relationships and social skills. Garst et. al. (2001) found significant increases in feelings of social acceptance immediately after an outdoor adventure program, with increases in behavioural conduct (i.e. improved listening skills and increased anger control) four months after the program.

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