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Published in:
Journal of Agricultural and Environmental Ethics

DOI:
10.1007/s10806-012-9411-1

Published: 01/08/2013

Document Version
Peer reviewed version

The Ethics of Assisted Colonization in the Age of Anthropogenic Climate Change

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Abstract

This paper examines an issue that is becoming increasingly relevant as the pressures of a warming planet, changing climate and changing ecosystems ramp up. The broad context for the paper is the intragenerational, intergenerational, and interspecies equity implications of changing the climate and the value orientations of adapting to such change. In addition, the need to stabilize the planetary climate by urgent mitigation of change factors is a foundational ethical assumption. In order to avoid further animal and plant extinctions, or at the very least, their increased vulnerability to becoming rare and endangered; the systematic assisted colonization of “at risk” species is being seriously considered by scientists and managers of biodiversity. The more practical aspects of assisted colonization have been covered in the conservation biology literature; however, the ethical implications of such actions

have not been extensively examined. Our discussion of the value issues, using a novel case study approach, will rectify the limited ethical analysis of the issue of assisted colonization of species in the face of climate change pressures. Beyond sustainability ethics, both animal and environmental ethical approaches will be used and intrinsic versus instrumental value orientations in the literature shall form the basis of our discussion. After the application of all the ethical approaches to the case studies, we conclude that without mitigation and the prospect of a future stable climate, assisted colonization will be involved in an inherently unethical process and a "move and lose it" outcome. With mitigation, there is wide-ranging ethical support for assisted colonization.

Keywords: Ethics; Climate change; Assisted colonization; Instrumental; Managed relocation; Mitigation Adaptation; Intrinsic value; value; Sentience; Environmental ethics; Sustainability ethics

Introduction

Climate change sets a challenge to the human-nature relationship and poses a number of dilemmas for conservation science and policy. Extensive species extinctions are possible, particularly at more than 2 °C of global warming (Thomas et al. 2004; Warren et al. 2010), as are surprises and novel ecosystems (Hobbs et al. 2006; Williams and Jackson 2007). The projected rates of change may be too fast to allow species to migrate (Malcolm et al. 2002; Loarie et al. 2009), and ongoing landscape fragmentation by human development will limit the possibilities for movement to more favorable locations (Fischlin et al. 2007). It is in this context that a new form of species acclimatization is being considered that involves the managed relocation or assisted colonization (AC)1 of species as a potential climate adaptation measure for conservation.

A great deal of the AC debate has been framed as a case of differing risk perceptions centered around the risk of doing nothing, the risk of acting, and the degree of ecological certainty (McLachlan et al. 2007). Opponents of AC claim that limits to our ability to assess ecological risks, such as invasion and hybridization, mean that it should be rejected as a viable conservation strategy: at best it is "techno fix" that would divert resources from ambitious large-scale restoration and innovative management strategies (Fazey and Fischer 2009); at worst, it is ecological roulette (Ricciardi and Simberloff 2009). However, other authors argue that given the scale of the challenges ahead there will be instances in which AC is an appropriate response, and the risks of action need to be weighed with the risks of doing nothing (Seddon 2010; Hoegh-Guldberg et al. 2008; Vitt et al. 2010). In fact a failure to undertake AC can been seen as actively favoring by default those taxa unaffected by climate change or uninhibited in their capacity to migrate (Thomas 2011). There is also a need to ensure that AC does not occur in a science and policy void (Schwartz et al. 2009).

While other authors have considered the ethical and policy implications of radical AC (Minteer and Collins 2010), its formal ethical justification within the conservation community (Sandler 2009) and its conservation policy implications (Camacho et al. 2010), we take a broader view which considers the analysis of species survival in the context of sustainability ethics (Norton 2005). We believe this approach addresses the equity dimensions of adaptation funding and policy decisions that are currently being considered by governments worldwide. These considerations go well beyond a strict focus on biodiversity conservation policy and detailed philosophical perspectives on the value of species. Moreover, we argue that the application of sustainability ethics, sentience, and ecological ethics in the evaluation of AC has the potential to reveal the full implications of anthropogenic climate change as it takes us into the unknown territory of an additional 4–6 °C warming driving many species into increased vulnerability and possible mass extinction.

The question of why to undertake neo-acclimatization in the form of AC goes much deeper than practical scientific and risk management arguments. For us to understand the conservation policy rationale for moving species as a response to climate change, we consider some general ethical considerations surrounding climate change, namely intragenerational, intergenerational, and

interspecies ethics, specific issues raised in two “ethically loaded” case studies and finally, an assessment of the values potentially held by various actors.

Climate Change and Ethics

Climate change adaptation and mitigation are fundamentally ethical issues (Gardiner 2004; Page 2007; Arnold 2011) as they force us to confront the problem of global distributive justice, or how benefits and burdens should be distributed within (intra) and between (inter) generations (WCED 1987). Atmospheric pollution at a global scale is a relatively new ethical issue. While there has been concern about local air quality since the industrial revolution, the atmosphere as a whole seemed to satisfy the principle of plenitude (Ewin 1981) in that there seemed to be so much of it that humans could pollute without any consideration of limits or consequences. However, now that we recognize that there are limits to what we can do to the atmosphere and that there are immediate and future consequences of our actions on the atmospheric commons, global climate has become a central focus for ethical consideration in the twenty-first century. A further major shift in ethical reasoning has seen a movement away from an overwhelming fixation on the distribution of benefits and burdens in the here-and-now to serious consideration of these issues in an uncertain future. In a third major change, the refocusing of ethics has required movement from purely individualistic, human-centered or anthropocentric ethical considerations to sentient non-human animals, intrinsically valuable living things, and whole ecosystems where human affairs become part of much wider ethical contexts.

Intragenerational Ethics

The intragenerational ethical aspects of climate change are highlighted by the fact that some human communities have already had their lives directly and negatively affected by, for example, rising sea levels and melting glaciers (Parry et al. 2007). Moreover, some non-human species, as shall be discussed below, have also had their endemic environment changed in ways that affect phenological and other life supporting relationships (Albrecht 2011).

As a result of current impacts of climate change, there are important ethical questions to be asked of current generations of humans such as “who should bear the burden of preventing further and potentially dangerous climate change?” The principle of historical responsibility suggests that countries should be accountable in proportion to their contribution to the problem, and here developed countries hold a unique ethical responsibility because they lead the world in terms of ongoing and cumulative emissions (Page 2008).

Alternatively, the principle of ability to pay means that parties with the most resources should contribute disproportionately to the solutions. This would mean that emergent “rich” countries that have not historically contributed much to the climate change problem and are now “wealthy” due to, for example, oil production, are ethically obligated to contribute generously to solving the problem. It is for this reason that the United Nations Framework Convention on Climate Change speaks of “common but differentiated responsibilities” when it comes to avoiding dangerous climate change (UNFCCC 1992, Article 3).

Key intragenerational equity questions include responsibility for climate change impacts, the distribution of the costs and benefits of adaptation infrastructure, compensation for residual damages, and fair participation in planning and adaptation decision-making (Grasso 2009). Paavola and Adger (2006) suggest that principles for just adaptation to climate change should include avoiding dangerous climate change, forward-looking responsibility, putting the most vulnerable first, and equal participation of all. A number of attempts have been made to investigate a fair allocation of responsibilities for financing adaptation to climate change; for instance Dellinka et al. (2009) propose a conceptual framework based around the principles of no harm; polluter pays; precaution; and capacity to pay. However, as noted above, no firm commitment has been forthcoming from the international forums dedicated to the issue of climate change to any of the principles that would fully address the intragenerational equity issues impacting humans.

While substantial amounts are currently allocated by both government and private interests to conservation of economically unimportant non-human species in the wild, maintaining such funding

should climate change start to increase human poverty on a global scale will inevitably produce ethical dilemmas. As it is, the areas protected for conservation are often closely associated with wealth (McDonald and Boucher 2011) and there is already debate and indeed public protest in some countries over whether people or biodiversity should have precedence in areas of extreme poverty and land shortage (Sharachchandra et al. 2010).

Intergenerational Ethics

Climate change occurs over long time scales and so actions taken now—or not taken—will impact many generations to come. One aspect of intergenerational justice, the resourcist view (Page 1999), is that existing generations should not despoil the natural environment or the climate system and each generation should hand down to the next a no less abundant share of natural resources than that which it inherited from previous generations.

The environmental ethic of Stewardship (Passmore 1974; Attfield 1983) holds that it is an important role of humans to maintain nature and not wantonly destroy it. Stewardship arises out of anthropocentric ethical traditions and has instrumental values as its foundation. As opposed to despotic and tyrannical relationships, stewardship is a respectful and responsible attitude and ethic toward the environment. The ethical issues stewardship raises will repeatedly appear as natural resources, upon which humans depend, dwindle. The idea of intergenerational stewardship discussed by Page (2007) is that the existing generation is bound by the duty of indirect reciprocity to protect environmental resources for posterity in return for the benefits inherited from their ancestors. Each generation is free to make use of the world's resources as long as it does not degrade or destroy the inheritance of later generations.

As with intragenerational equity, the application of ethical considerations to future generations of non-human species may be problematic. The protective umbrella of ethics has been expanded by "Western" societies in the last one hundred years to include those who were formally excluded from such protection (women, non-whites, sentient animals). However, while threatened species legislation exists for many countries, expansion of protection to all non-human beings tends to be poorly

resourced. Climate change will require that humans undertake serious consideration of intergenerational, interspecies equity.

Interspecies Equity

An important subset of equity consideration is interspecies ethics, where, as per those humans who have no direct responsibility for the problem of global warming, naïve, non-contributing and non-consenting non-human beings are caught up in massive change imposed on them by humans (Albrecht 2006).

The ultimate objective of the United Nations Framework Convention on Climate Change UNFCCC) is to prevent dangerous anthropogenic interference with the climate system in a time frame sufficient to "allow ecosystems to adapt naturally to climate change" (UNFCCC 1992, Article 2). Adverse impacts on ecosystems have already been observed (Parmesan 2006; Fischlin et al. 2007), but making the case for what "dangerous climate change" might be has been difficult due to lack of data as well as the different scales and methods employed in impact studies. However, a recent meta-analysis by Warren et al. (2010) concluded that from an ecological perspective, 2 °C is a defensible threshold for the maximum allowable climate change.

As indicated above, some species are already significantly affected by warming of approximately one degree over the last 100 years. On the basis of current and anticipated future impacts on non-human species it is clear that humans have an ethical responsibility founded on basic equity considerations to help, if possible, affected species to adapt and cope with imposed change. As is analogous to the case with humans, non-human species who have contributed nothing to the climate problem will be the most seriously affected by the changes imposed on them. It is within this context that neo-acclimatisation in the form of AC must be considered as a serious measure to rectify interspecies injustice.

The Ethics of Neo-Acclimatization

Two issues precede ethical consideration of assisted colonization:

1.Can the species be moved? And,

2.Is there a place to which to move the species?

As the philosopher, Immanuel Kant put it, “ought implies can.” Any ethical consideration has to be a consideration of what can be done. In light of humans refusing or demurring to either cease or reduce the causes of climate change, large ethical questions are raised:

> Is it ever ethically acceptable to move a species from one location where it naturally occurs to another location where it does not occur or has not occurred in recent times? And,
>
> If so, under what circumstances is it ethically permissible?

If we can answer “yes” to the first question then this answer may depend on one or more of several ethical perspectives. For example, on a utilitarian ethic, it is permissible when it achieves the greatest good or preferred state for species being moved and the location to which the species is moved. Another example is when it is the virtuous thing to do. If it is a choice between extinction and possibly saving a species, then it is permissible. Yet a third example is stewardship. If humans have the capacity to save a species by moving it to a location where they will modify the ecology of the location without devastation, it is permissible. It can be argued that humans have a duty of care for current generations and future generations not just of humans but of other species as well. If humans can carry out that duty of care by AC and that AC does not violate the harm principle, (we are free to act as long as we do not inflict harm on other individuals) then humans have a responsibility to preserve other species.

The second question is harder to answer. It requires consideration on a case by case basis. Where the introduction of a species does not do harm to its new habitat, it is permissible. Where the introduction does not endanger a species already in the new habitat, it is permissible.

Acclimatization in the form of AC is ethically controversial because it simultaneously challenges and aligns with different ethical principles, approaches to interspecies equity in the form of biodiversity preservation (Loss et al. 2011), directly engages with anthropocentric ethics, sentience-based animal ethics (Singer 1975) and requires serious consideration of intrinsic value under ecological ethics (Leopold 1966).

In order to consider AC, we can apply sentience-based ethics in the case of sentient species and ecologically derived ethics in the case of sentient and non-sentient species and their place in the biotic community. The development and application of an ecologically based ethics to the issue of relocation of species was pursued by Albrecht (1998, 1999) in the context of the return of rehabilitated animals to the wild, the release of captive bred animals into the wild and to the relocation of animals such as the Koala (Albrecht 2001). These publications argued that in addition to sentience-based considerations, the impact of reintroductions and relocations should have ecological ethical considerations about the value of the total biotic community (Leopold 1966) applied as well. The expansion of animal ethics to include ecological ethics will now be applied to the issue of AC in the context of climate change.

From Preservation to Radical Conservation Ethics

Some authors argue that climate change is forcing a fundamental reassessment of the underlying goals and values of preservation and conservation. Minteer and Collins (2010), for example, suggest that saving a species in the twenty first century means moving policy from a traditional preservationist agenda (leave nature alone) towards more pragmatic and interventionist approaches to conservation science and action as, "… makers of novel ecosystems for stressed populations, including animal, plant and human." However such interventionist approaches need to carefully differentiate themselves from various forms of historical hubris exhibited towards nature by humans in the past. The hubris of thinking that humans are able to reorganize, control and manipulate nature and the hubris that humans

are somehow not part of nature (Vitt et al. 2010; Hellman, in Marris 2008) have both been used to support despotic, exploitative and crudely instrumental relationships with the rest of nature in the past.

The current trajectory of climate change holds a high probability of exceeding the 2 °C increase in temperature threshold discussed above (Anderson and Bows 2011). One argument suggests that, since we can predict with a high degree of certainty that this will render some species extinct, we should follow the "move it or lose it" strategy (Minteer and Collins 2010). It is argued that it is ethically and practically preferable to have a species exist than to have it become extinct. Minteer and Collins put the case that:

> If climate change continues unabated and as rapidly as a few models predict, saving at least some species will require solutions more radical than creating parks and shielding endangered species from bullets, bulldozers, and oil spills: It will require moving them. (Minteer and Collins 2010).

However, the crucial question remains, to where do we move species? This is not a new problem, it is the "There Problem" of currently breeding in captivity to put animals such as orang-utans and koalas back into their natural habitat. However, when their habitat is threatened or destroyed by such practices as agricultural and urban development, there is no "there" to put them. If climate change continues unabated and is rapid, then the places where we move species will also be undergoing change that will most likely negate the value of the relocation in the first place. At that point, all the effort to move species will be to no avail unless we keep moving them to more favorable locations. It is perhaps for this reason that Minteer and Collins have forwarded the idea of constructing new neo-acclimatization spaces for human survival and the conservation of some non-human species. They argue:

> … whereas historically we have taken on the role of preservers of species and ecosystems, in the 21st century we will likely find ourselves pressed into a very different role: makers of novel ecosystems for stressed populations, including animal, plant, and human. (Minteer and Collins 2010).

We shall now examine the ethics of both situations where species are moved to new "natural," locations and finally, to entirely new and artificial places where they can conceivably continue to exist. The interspecies equity considerations shall be undertaken through the application of sentience and ecosystem based ethical traditions together with instrumental and intrinsic value orientations.

Sentience-Based Ethics

The movement of sentient animals involves ethical issues of capture, transport, and relocation stress. Ongoing disturbance to sentient species might well be ethically unacceptable irrespective of the noble end of saving species from extinction. The questions must be raised, how much stress do we put animals through in order to save them? How much stress will resident species suffer as neo-acclimatization species are moved into "their" habitat?2 We have a cascade of ethical considerations that complicate what might initially appear as a humane and ethically motivated gesture.

However, as argued above, without climate change mitigation, we are committing sentient species to the escalation of pain and distress as they are negatively impacted by extreme climate and the imperative to move/migrate under such pressure. Such distress could be reduced by human intervention in the form of AC but again, without mitigation, we could be involved in an ethically and economically costly exercise of "move it and lose it" as the number of "wild" places on earth that fit the eco-evolutionary niches and requirements of species contracts. If we have clear targets for the stabilization of greenhouse gases and global temperature, then the pain and distress of neo-acclimatization in the form of AC might be justifiable. It might also be justifiable if, in the absence of all other options and global temperature continues to rise, sentient species are moved into purposefully constructed sanctuaries that save them from extinction. The ethical question then is which species and individuals are chosen, and which left "out in the heat."

Ecological Ethics

Intrinsic value arguments for the preservation of species hold that living things have an essential, inherent value in themselves, unlike instrumental and prudential arguments that hold entities have

value only because humans value them. While we acknowledge the variety of positions in the literature with respect to intrinsic value (Sandler 2009), we argue for a view of intrinsic value as independent of human valuers3 and ultimately, for individual species, independent of the specific location within which a species has traditionally existed. The latter consideration is driven by the prospect that because of anthropogenic climate change humans have already shifted eco-evolutionary zones (and will do so to an even greater extent into the future), moving a species to keep it within its evolutionary niche becomes an ethical and scientific commitment to its intrinsic value based on the best estimate of where that species can continue to live so as to meet its basic genetic, behavioral and ecological needs (its evolutionary trajectory). That is, humans must anticipate where a new habitat can deliver the ongoing needs of a species so that it can maintain its evolutionary trajectory. The new habitat will have intrinsic value that approximates the intrinsic value of the former home habitat of the relocated species, but obviously, it will not be the same.

We argue that entities with intrinsic value should never be treated solely as means, but as ends-in-themselves, a principle expressed as an equity statement in the environmental philosophy of deep ecology as "biocentric egalitarianism" (Naess 1973). An entity with intrinsic value may also have an instrumental value, but should not be reduced only to its instrumental value. In the context of climate change, species, be they sentient or non-sentient, have intrinsic value as do, by implication, the ecosystems/habitats within which they live. Those who hold an intrinsic value orientation would argue primarily for the mitigation of climate change because global warming works against the intrinsic value of the "flourishing of human and non-human life" (Naess 1973; Devall and Sessions 1985).

An ecological approach to ethics that can be used to defend the intrinsic value of whole ecosystems is to be found in Aldo Leopold's Land Ethic. Leopold famously argued:

> A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise. (Leopold 1966).

Applied to AC, this argument suggests that without considerations of the integrity and stability of a given ecosystem, intervention with particular species would, under this principle, be ethically dubious. In the event that the whole ecosystem cannot be saved, and a relocation exercise is to be seriously considered, then under Leopold's Land Ethic, the essential elements (keystone species) of the whole ecosystem would need to be relocated. It will undoubtedly be a severe test of our ability as biodiversity stewards to successfully transplant the intrinsic value of an ecosystem that has evolved in one location to another. The culturally contested issue of "beauty" is also briefly considered below.

The implications of the ethical issues involved with the different approaches to neo-acclimatization conservation are considered below via two case studies that suggest hypothetical solutions to potentially vulnerable species. While we have no opinion on whether either of these potential examples of assisted colonization has ecological merit, we are proposing these examples as heuristic devices to demonstrate the complex ethical issues now facing society in dealing with anthropogenic climate change. We argue that sustainability, sentience and ecological ethical considerations are all vital to the evaluation of our options and that all three could be used to support AC in certain circumstances.

Case Study 1: The "New Zealand" Mountain Pygmy-Possum (Burramys Aotearoa parvus)

The Australian Mountain Pygmy-Possum (Burramys parvus) is a little known animal that could be among the first wave of species to be rendered extinct by anthropogenic climate change. Three isolated populations of the possum live in an area of <7 km2 in the highest parts of south-eastern Australia (Broome 2008). They live in boulder fields at high elevations and appear to rely on the migratory Bogong Moth (Agrostis infusa) for food, though they also eat a variety of seeds, such as those of mountain plum-pine (Podocarpus lawrenceii). They were widespread when the climate was colder and now face numerous threats in their remaining alpine habitat, many of which are likely to be

exacerbated by climate change (Broome 2008). Total population estimates vary from 500 to approximately 1,000 individuals.

While alpine habitat does exist in Tasmania, still within Australia, it is at a lower altitude and so is likely to provide only a temporary climatic refuge should the pygmy-possum be moved there. However the South Island of New Zealand has a far greater altitudinal range so, hypothetically, could be suitable for the species over a much longer period. There are also close relatives of the mountain plum-pine growing in the New Zealand mountains, although there is no equivalent to the Bogong Moth, a species which, in Australia, aestivates in alpine boulder fields in such large numbers that the collection of moths was once a major feature of Aboriginal livelihoods in the Australian alpine region (Bowdler 1981).

However, three of many complications stand out. First, New Zealand already has one introduced possum species, the Australian Brush-tail Possum Trichosurus vulpecula. While many marsupial introductions have failed, marsupials as a group were the first mammals known to have been translocated by humans (Heinsohn 2010), and Brush-tail Possums are causing major changes to New Zealand ecosystems (Montague 2000). Thus the introduction of a different species of possum to an island that lacked non-volant mammals until the arrival of people could have inter-generational consequences. Second, New Zealand now hosts not only Brush-tail Possums, but a range of highly effective introduced predators including stoats Mustela ermine which are absent from Australia and could reduce the chances of successfully establishing the pygmy-possum, and provide a new source of stress for the animal. Third, Bogong Moths do migrate regularly to New Zealand, and will breed there, but the moth larvae currently fail to survive New Zealand winters (Fox 1978). From a practical point of view, the regular survival of Bogong Moth larvae as a result of global warming, and the establishment of the species as a New Zealand resident, could be seen as the trigger to initiate introduction of the pygmy-possum.

It is clear that there are the elements here to seriously consider the AC of the Mountain Pygmy-Possum. We have an endangered species whose habitat is shrinking because of global warming. They

cannot go any higher in Australian alpine ecosystems and New Zealand has much higher mountains. While New Zealand might not be an ideal relocation proposal, the issues of cultural acceptance of a new possum species and threats from predators are not insurmountable. The acceptance by traditional owners of new species in emergent hybrid eco-cultural environments has been discussed by Albrecht et al. (2009) in the context of Northern Australia and the introduced Asian Swamp Buffalo (Bubalus bubalis). Unlike buffalo, Mountain Pygmy-Possums are small (mouse sized), arguably "cute" and offer none of the threats of the larger Brush-tail Possum and they therefore could be incorporated into contemporary New Zealand culture without controversy. New Zealanders just might be quick to embrace the new little possum into their land, especially if the reason for its introduction is to save it from extinction. The beauty of the animal and the fact that it is harmless to humans all work in its favor. The predatory stoats are a serious issue but controlling them is not in principle any different to controlling feral cats (another very effective predator) or foxes. The control of such introduced predators is necessary in any case for New Zealand birds (for example, the flightless Kiwi) and something with which New Zealand conservation managers have decades of experience.

The issue with the Bogong moths could be a bonus for Mountain Pygmy-Possum in New Zealand, one that could see symbiosis between the two species re-emerge in a new location favorable to both. The essential elements of the intrinsically valuable mountain ecosystem of Eastern Australia are then replicated in a New Zealand location and the intrinsically valuable species of the (former) Australian context can continue their evolutionary trajectories and are saved from extinction. There seems to be no potential for serious violation of either the interests of Mountain Pygmy-Possums or a major threat to the host ecosystems over and above the risks presented by climate change itself. Mountain Pygmy-Possums have been successfully bred in captivity and their introduction to a number of new in-the-wild locations in both Australia and New Zealand would be an expression of a wise stewardship strategy of safety in diversity. When an animal is already endangered and its original habitat is disappearing, the risks of possible harm have to be weighed up against the risk of extinction. As long as no net harm is caused to the parties involved in both Australia and New Zealand, there is an a priori case for AC in this case study. Finally, the Mountain Pygmy-Possum can be returned to Eastern

Australia if and when the global climate is returned to one that permits its re-introduction to its former home.

Case Study 2: The “South” Polar Bear (Ursus Antarctos Maritimus)

More radical is the suggestion that the polar bear be introduced from the Arctic to the Antarctic on the assumption that the Arctic could be free of summer sea ice as early as 2040 (Holland et al. 2006).4 There is a real possibility that polar bear habitat will rapidly contract to such an extent that adaptation is impossible and the polar bear’s extinction likely. It seems that humans like the appearance of polar bears (especially cubs) and view them as a beautiful and “charismatic” species that would be worth saving in the event that they might be lost due to climate change. Given such a context, it is interesting to think about how ethics and public support could be used to justify AC as the Arctic ice disappears.

Polar bears are apex land predators in the Arctic, and there is increasing concern that they are under climate change pressure at present and will decline in numbers (Wassmann et al. 2010; Hunter et al. 2010). They are being forced into longer foraging voyages as the ice floes from which they hunt and feed fragment and melt, putting them in increasing danger of exhaustion and drowning (Monnett and Gleason 2006). In addition, should the polar bear attempt to maintain its presence on the North American mainland, it could suffer extinction due to hybridization by interbreeding with the closely related grizzly bear (Ursus arctos horribilis).

As suggested, one potential way of saving polar bears, other than holding them in zoos, is to relocate a population to the Antarctic. According to even the worst case scenarios for global warming, the Antarctic land mass will continue to be home to permanent ice long after Arctic sea ice completely disappears.

While there are seal populations in the Antarctic, none of them are the species that polar bears normally eat. Nevertheless, it is highly likely that polar bears could adapt to eating different species.

In addition to six seal species (Antarctic Fur Seals, Crabeater Seals, Leopard Seals, Ross Seals, and Weddell Seals) there are four Antarctic (Adelie, Chinstrap, Emperor, and Gentoo) and three sub-Antarctic (King, Macaroni, and Rockhopper) species of penguins in the Antarctic. Polar bears could most likely adapt to eating penguins, an animal that now also has international charismatic appeal after box office hit movies such as “Happy Feet.”

Adding to penguin predators would most likely lead to the premature endangerment of already declining penguin populations as they too are under pressure from climate change. Jenouvrier et al. (2009) found that, given current climate change projections, the median population size of a large emperor penguin colony in Terre Adelie, Antarctica, will likely shrink from its present size of 3,000 to only 400 breeding pairs by the end of the century. To avoid a massive predatory impact on penguins, the bears would have to be placed on islands more than 60 miles (100 km) (Stirling 1988) from land masses with penguin colonies, but these islands would have to have a supply of seals or other acceptable food for the bears.

For instance, an island such as Bouvet Island, a Norwegian dependency supporting substantial populations of many abundant Antarctic species is 1,750 km from Antarctica, and could be considered suitable. Given that Norway has a natural population of Polar Bears on Svarlbad, the translocation would not require international approvals. Alternatively, the bears could be managed to prevent them predating on penguins while they are breeding. If we are going to go to the fiscal and ethical expense of moving polar bears, then the budget might have to include the electric fencing of the breeding penguins to protect them from predatory bears.5 Active management of bears in the form of constant relocation away from penguin breeding locations and, if necessary, as is the case with contemporary bear control in Scandinavia and Canada, expert shooting of bears that are in the “wrong place” are possible options. In addition to these measures, making sure that isolated sub-Antarctic islands such as Macquarie Island remain as safe sanctuaries for penguin breeding will be important management tools.

The dilemma of the polar bear presents us with a number of ethical conundrums. If its habitat continues to contract then drowning and starvation will increase. Breeding success will decline and, in a classic illustration of "move it or lose it," the polar bear will disappear from the Arctic and the Earth.

Given its charismatic status and the fact that there is already an extensive ecotourism industry based around Arctic experiences that include close-up encounters with polar bears, for purely anthropocentric and instrumental reasons there might be some support for moving polar bears south.

Further, by moving polar bears to the Antarctic, human intra- and inter-generational ethics are satisfied as we still have a planet with wild polar bears that humans can enjoy. If mitigation is successful, and we avoid crossing irreversible tipping points, then there is the possibility that polar bears could be returned to the Arctic at some point in the future. We then satisfy anthropocentric inter-generational equity in that the species remains for future generations of humans to experience in its original habitat. If mitigation is not undertaken, or is not successful, then radical conservation will inevitably involve new types of zoos where polar bears continue to exist, but totally at the generosity of human beings and their willingness to share their wealth and intelligence in the service of another species.

Those motivated by sentience ethics would want something done to reduce the suffering of polar bears under climate change. Assisted colonization to places where drowning and starvation can be avoided would have to be seriously considered. The ethical issues of pain and distress involved in trapping and relocating the bears would be formidable, but given that humans are experienced in the relocation of bears to zoos, that task should not be excessively stressful on bears. Moreover, in a simple utilitarian calculation, the pain and distress of relocation will be considerably less than the pain and distress of total population death by starvation, drowning, and forced culling by humans.

In addition, if we apply an ecologically influenced ethic, we might be tempted, along with intrinsically valuable polar bears, to move other Arctic species that are vital parts of the bears' food chain and ecosystem. Some elements of that food chain are already established in the Antarctic:

reindeer have been successfully introduced to both South Georgia and Kerguelen islands (Christie 2010), demonstrating that species translocations from Arctic to Antarctic ecosystems were once thought ethically non-controversial. In this way, intrinsically valuable elements of the doomed Arctic biotic community will be saved rather than a single species. There may even be a reasonable argument to suggest that as much as is possible of the Arctic ecosystem should be moved south as a gesture of planetary stewardship that enables the biodiversity of the cryosphere to continue on its eco-evolutionary trajectory.6 The entry pressure of an apex predator such as the polar bear would be dissipated through a more complex and diverse Antarctic ecosystem and the impact on penguins minimized. No doubt the new predator will cause pain and distress in the individual animals that it eats, but in sum, no more than what would have occurred if their original habitat had remained viable and the bears had continued to eat the sentient creatures of the North.

In the context of choices with polar bears that involve doing nothing, undertaking AC to shift species to suitable emergent habitat or relocating some of them to "über zoos" where they remain in captivity for the foreseeable future, AC to Antarctica just might be the most ethically acceptable option.

Discussion

Neo-acclimatization in the form of actions such as AC may be humanity's last resort to save so much that is valuable of the planet's biodiversity. This is because, as argued in the editorial of The Economist:

> Climate change is one of the hardest policy problems the world has ever faced. Because it is global, it is in every country's interests to get every other country to bear the burden of tackling it. Because it is long term, it is in every generation's interests to shirk the responsibility and shift it onto the next one. And that way, nothing will be done. (The Economist, 9 September 2006, p. 9)

In recognition of the fact that so far, we continue to head towards dangerous climate change, we are forced to retreat into a second order examination of the ethics of adaptive responses. Such adaptive

responses, as argued above, are rational and ethically defensible if and only if future mitigation is effective enough to bring greenhouse gas levels down from their present level to a “safe” level.

As argued by some, 350 parts per million CO2e in the atmosphere is a reasonable internationally binding target to aim for in order to reduce the risk of irreversible and dangerous climate change (Hansen et al. 2008). The achievement of such a goal would deliver a degree of predictability for the medium to long-term future and enable adaptive actions to be initiated. In such circumstances, adaptive strategies such as AC have ethical justification and we should begin to plan and think about the implications of the assisted colonization of species to “new” more favorable habitat and their possible re-introduction to their former home habitat once a more “stable”7 climate returns.

Active conservation challenges traditional preservationist based ethics and agendas,8 and it forces advocates of assisted colonization—and adaptation for species and ecosystems more generally—to better understand value systems in addition to those that are purely anthropocentric and instrumental. Both ecological ethics and sentience-based ethics are needed to fully appreciate the equity considerations implied in the sustainability principle of interspecies equity.

Ethical norms are a genuine part of mission- or crisis-oriented disciplines such as conservation biology (Soulé 1985) and even among conservation biologists there are divergent value systems that influence approaches, with some, stressing ecological ethics, placing a premium on protecting species in their native habitat, while others, using more instrumental values, are willing to translocate species to prevent their extinction despite the risks and imposed stressors (Schlaepfer et al. 2009). Likewise other actors in conservation policy and assisted colonization efforts—decision-makers, funders and the public—may hold different underlying values even if they agree on the need for assisted colonization.

An example of the tensions generated by differing value systems is provided by the current international policy paradigm concerning climate change adaptation and ecosystems. Ecosystem-based adaptation measures refer to sustainably managing, conserving and restoring whole ecosystems so that they continue to provide the services that allow people to adapt to climate change (IUCN

2011). Such an argument has been provided as a reason why donors and governments should pay particular attention to healthy ecosystems and environmental protection in adaptation efforts. It is, however, a purely instrumental and anthropocentric argument; healthy waterways help humans adapt to climate change, while preserving the intrinsic value of snow leopards does not.

Constructing a rationale for adaptation in the form of AC with reference to instrumental value and other human-dependent values is fraught with peril for those who believe that species should be saved—whether by conventional conservation measures or by assisted colonization—on the basis of their objective intrinsic value, or to fulfill Article 2 of the UNFCCC. The climate convention mentions that our mitigation efforts should be such that species can adapt naturally to climate change, but why we should do so is up to interpretation. The Convention on Biological Diversity is more explicit, the first sentence of its preamble making it clear that all parties to the Convention must be: "Conscious of the intrinsic value of biological diversity and of the ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values of biological diversity and its components…"(CBD 2012).

We argue it has been the failure to fully appreciate the objective intrinsic value of biological diversity (species and habitat) and the overwhelming dominance of human-defined instrumental values that are the main reasons why we are facing the prospect of dangerous climate change and other manifestations of ecosystem distress in the first place. To rectify the imbalance between instrumental and intrinsic value, radical conservation efforts based on AC can in principle be supported and defended, as was illustrated in our two case studies.

As argued throughout this paper, any abandonment of mitigation of climate change involves a massive failure in human ethics. Given the reality of a rapidly changing climate and rapidly shifting eco-evolutionary zones for all species, the protection of intrinsically valuable species by active AC becomes by default an ethical imperative. The conservation of biodiversity is an integral part of the wider dialogues of sustainability and the distribution of development and climate change adaptation funds from international bodies and donors will have massive implications for biodiversity. This is the

case, not only because much of the remaining biodiversity of the world is to be found in the undeveloped areas of developing countries, but also because many of these countries are the most vulnerable to the negative impacts of climate change. Moreover, as population increase, development pressures and climate change simultaneously impact on the frontiers of human settlement and existing or proposed conservation zones, conflict between humans and endangered biodiversity will become more frequent. Humans and non-human animals that can move will move in any case under the pressure of climate-induced habitat change and this will cause conflict.

Human versus non-human conflict will work against the very possibility of AC unless the location and lifestyle of humans is also considered within the matrix of re-location options. Such considerations inevitably engage the social sustainability issues of human justice and equity that must be incorporated alongside the ethical justification of AC for non-human species.

If AC, under the influence of strong sustainability and intrinsic value environmental ethics, fails to protect non-human species then we are left with no option but to construct artificial refuges where there is complete human manipulation of a "closed" controlled environment for humans and some non-human species within a constantly shifting and hostile external climate. Yet, the very idea of creating a new Noah's Ark that takes some humans and some animals into a vastly different world because of a monumental human ethical failure is one that has a strong feeling of déjà vu about it.

Acknowledgements

The authors wish to thank the National Climate Change Adaptation Facility (NCCARF) for funding the genesis of this paper at a multi-disciplinary assisted colonization workshop in York, Western Australia in 2010. Also the anonymous reviewers for their helpful comments on an earlier version of this paper.

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