SOCIETY FOR ECOLOGICAL RESTORATION INTERNATIONAL
Policy Position Statement
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Ecological Restoration and Rare Species Management in Response to Climate Change

RATIONALE

The effects of climate change on rare, endangered, and endemic species are highly variable, including geographic range shifts as well as changes in relative species abundance, phenology (breeding/blooming), and other ecological aspects of their biotic communities (Thuiller et al. 2005). Disruptions in community dynamics, such as predator-prey and plant-insect interactions (Parmesan 2006), alterations in biogeochemical cycles, and increased disease, pest, and non-native species invasions are all on the rise (CCSP 2008). Indeed, the interaction of climate change with other human-induced environmental changes (e.g. habitat loss, landscape fragmentation, and other modifications due to extinctions and invasive species) have already resulted in major alterations in the structure, composition, and functioning of many ecosystems (MA 2005; Bradshaw & Holzapfel 2006; van Mantgem et al 2009), some of which may be irreversible.

On a macro scale, the predominant response of species to climate change pressures is a poleward expansion or changing of geographic ranges in search of more suitable habitat at higher latitudes. Many plant and animal species are shifting their ranges towards higher elevations (Lenoir et al. 2008), while coastal plants and animals are expected to migrate inland to escape the stresses associated with sea level rise (National Wildlife Federation 2007). In the past, extinctions and population declines were avoided or mitigated as climate changes were more gradual, habitat connectivity was stronger, and many species were able to adapt by shifting or expanding their range, migrating elsewhere, or evolving *in situ*. Today, environmental changes are accelerating rapidly, and many individual species, discrete populations, and whole species assemblages are now threatened with extinction. This has major implications not only for the practice of ecological restoration (Harris et al, 2006) but also for conservation and the sustainability of natural resource use.

CLIMATE CHANGE IMPACTS ON RARE SPECIES

Many species of plants and animals considered to be threatened or endangered may have become so not only as a result of their narrow biogeographical ranges, but also due to habitat loss and fragmentation; predator, parasitic, and/or competitor invasions; and ecosystem modifications caused or exacerbated by human activities. Many of these species are found in what have come to be referred to as biodiversity hotspots, where studies point to a significant decline in species richness due to climate change (Malcolm et al 2006), among other global environmental changes. Indeed, unprecedented rates of extinctions are reported in tropical, subtropical and Mediterranean-type ecosystems. These examples from two recent articles are illustrative of the current situation:

> **"At the high end, projected extinctions in hotspots under doubled-CO^{2} climates were 39–43% of the biota, representing the potential loss of some 56,000 endemic plant species and 3,700 endemic vertebrate species. Individual hotpots in some cases showed extinctions of more than 3,000 plant species (Cape Floristic Region, Caribbean, Mediterranean Basin, Tropical Andes) and, in three cases, of more than 200 vertebrate species (Caribbean, Indo- Burma, and Tropical Andes)." Malcolm et al. (2006)**

> **"In this study, we modelled 975 endemic plant species in southern Africa distributed among seven**

life forms. Our results predict that impacts of climate change and current land transformation on endemic plant species in the study area are likely to be fairly severe, both at a geographic scale and a systematic level, with a 41% average decrease in species richness among habitats and a 39% average decrease of species distribution range (by 2050) for even the most optimistic scenario." Broennimann et al. (2006)

The variables or stressors most commonly associated with climate change, and which pose the greatest threat to rare, endangered, and endemic species and their habitats are:

1. **increases in sea levels** that result in the loss or transformation of coastal/intertidal habitats and saltwater intrusion into highly sensitive freshwater ecosystems;
2. **increases in surface and ocean temperatures** that result in geographic range shifts, loss of sea-ice, changes in species phenology, and fundamental regime shifts in some marine (e.g. ocean acidification), freshwater and terrestrial ecosystems;
3. **increases in carbon dioxide concentrations** which favor C3 plants over C4 plants;
4. **changes in precipitation** that fundamentally alter hydrologic and nutrient cycles, and result in more intense floods and droughts, with precipitation levels driving the extent of wildfires and warming trends fueling their intensity;
5. **increases in diseases, pests, and non-native species** that compete with native species populations and further limit habitat for potential refugia; and
6. **increases in the frequency and severity of storm events** that disrupt nutrient flows and cause further habitat loss.

These stressors must be understood in the context of large-scale conversion to intensive agriculture and forestry which limits the available area for biodiversity refugia and curtails important planetary feedback responses. This is where ecological restoration projects can play a critical role in improving species/habitat resiliency while diminishing some of the adverse effects of climate change and interrelated anthropogenic disturbances on rare and endangered species. By increasing habitat area and reconnecting fragmented landscapes, restoration is an important tool that can be used in conjunction with conservation and natural resource management programs.

Other management tools, such as assisted migration, species reintroductions, and the creation of refugia, may also be required in the effort to mitigate the effects of climate change and other global environmental changes on rare species. For example, without translocation or other human assistance, certain isolated reptile populations face certain extinction in the next 50 years due to their temperature-dependent sex determination (Mitchell et al. 2008). In fact, similar trends are apparent in most, if not, all phyla of animals and plants.

Assisted Migration as a Conservation Management Tool for Rare Endemic Species

Many protected reserves of limited size are no longer able to support healthy and resilient populations, and the lack of corridors for the dispersal and unassisted movement of endemic species at risk is the stated rationale for assisted migration. Without the timely restoration of landscape connectivity or expansion of current ranges, assisted migration as a conservation management option is perhaps the last chance for preventing certain climate-driven and other anthropogenic extinctions. Assisted migration refers to the human-aided translocation of select species or populations of plants and animals to suitable habitats outside their current or historic ranges as well as to harsher, sub-optimum microsites within their current ranges. It also infers that the successful establishment and colonization of the new target habitats by translocated species will require a certain degree of husbandry for an unknown period of time.

In Florida, the Torreya Guardians are aggressively pursuing an assisted migration plan that would move a seriously threatened charismatic conifer (*Torreya* *taxifolia*) further north by planting seeds and seedlings in the forests of southern Appalachia. Climate change has virtually eliminated habitat restoration as an option for preserving the species and with its relatively low potential for invasiveness, it may even take the place of similar species that are now in rapid decline in the forests of northern Georgia and South Carolina. Legal permission from the relevant authorities and coordination with affected stakeholders has presented the greatest obstacle to implementing this approach with the speed insisted upon by its supporters (http://www.TorreyaGuardians.org).

The costs and technologies associated with assisted migration are perhaps the most important determining factors when considering the feasibility of translocating a species or group of species. Some of the issues that need to be specifically addressed before translocation are: (1) how to determine population thresholds and other suitability requirements that call for translocation (e.g. those species most affected by climate change and unable to disperse without assistance are prime candidates for assisted migration), (2) how to identify and prioritize a suite of species to be translocated, (3) how to avoid or minimize any adverse consequences of translocations related to competition, mutualism, trophic associations and feedback mechanisms (McLachlan et al. 2007), and (4) how to develop technologies for the selection of adapted ecotypes or individuals within populations, and methods of effective propagation, outplanting, and monitoring.

Assisted migration is only one species management tool to be used only in extreme circumstances and with great care. In most cases, the money and efforts required would be better spent on mitigating pressures on native species by restoring habitat to create dispersal corridors, expand ranges, increase connectivity, and erect migration barriers to invasives.

ECOLOGICAL RESTORATION AND RARE SPECIES SURVIVAL

As there is little hope for a significant curtailment in greenhouse gas emissions (IPCC 2007) or major reductions in human-induced disturbances in the near future, innovative conservation and restoration projects are perhaps the most potent tools at our disposal to mitigate the adverse impacts of climate change and slow the rate of human-caused extinction of rare, threatened, and endangered plants and animals. Ecological restoration and conservation should not be considered as last resort activities, but rather as vitally important investments in the future sustainability of the planet.

The dispersal and adaptation of species to climate change has become increasingly difficult due to the lack of suitable habitats, migration corridors, and landscape connectivity. This in turn results in the isolation, fragmentation and heightened vulnerability of many populations and communities of rare and endemic organisms. To date, polar and montane species already pushed to their geographic limits have been the most vulnerable to extinction. In many coastal and island habitats, warming oceans have led to widespread coral die-offs and a rise in sea levels, while subsequent saltwater infiltration into freshwater water ecosystems has devastated populations already faced with increasingly restricted ranges. Recent studies have demonstrated accelerating rates of die-off in western US native tree species attributed specifically to climate change (van Mantgem et al 2009).

An integrated ecosystem approach, as championed by the IUCN, CBD and others, to the preservation of rare species is generally regarded, by restoration ecologists and conservation biologists alike, as the most effective strategy for achieving improved species/habitat resiliency. This holistic approach focuses on ecological structure, function, and complexity as they relate to the delivery of ecosystem goods and services that support rare populations, communities, and habitats which also contribute to the human pursuit of sustainable livelihoods (see May 2008 SER International Briefing Note). Care should also be taken to monitor rare and conservative species through the use of a Conservative Plant Index where (on a scale of 1 to 10) higher aggregate scoring serves as an indicator of overall habitat quality with regard to the conservation of rare species, and by extension, a rough indicator of overall ecosystem integrity. Some examples of holistic ecological restoration projects include:

(1) the creation and expansion of native habitats and migration corridors to minimize the effects of severe, localized weather events on rare endangered species by maintaining as many widely-dispersed and genetically-rich populations as possible;

(2) the restoration of coastal wetland ecosystems (e.g. mangroves and marshes) to provide critical buffer and transitional zones that enhance resiliency and adaptation in the event of sea level rise and severe storms;

(3) aggressive fire and fuel-load management techniques in forests and woodlands to avoid potential catastrophic fires that occur as a result of hotter and drier conditions, which also tend to favor fire-dependant native species, while providing a variety of habitat conditions (e.g. sun-shade, wet-dry, and open-dense) for maximum redundancy using variable-density thinning methods and regular prescription fire; and

(4) a "shotgun" approach to restoring sufficient habitat redundancy and diversity in order to ensure the availability of appropriate ecological niches for the conservative of rare species in cases where we lack an adequate understanding of the complex ecosystem processes undergoing rapid changes outside of the known range of historical variability. In highly fragmented habitats, "the placement of conservation areas on a north-south axis may enhance movements of habitats and wildlife by in essence providing northward migration corridors. Efforts to conserve habitats for single, or small numbers of species, should be concentrated in the northern portions of their range(s), where suitable climate is more likely to be sustained." (The Wildlife Society 2004).

(5) the conservation of rare species through "re-alignment" – that is, the management of native populations that have established themselves outside of their historical ranges (Millar & Brubaker 2006) or through the restoration of *in situ* resistance/resilience by selecting viable population ecotypes from poorer sites within species or population ranges for propagation and outplanting. While microsite variability may create harsher habitats that cause a loss of progeny, the individuals or populations that do survive may, for example, have drought, heat, and frost tolerance in early flowering, or other genetic traits that enable them to endure increased climate disruption. This is the only form of assisted migration for spatially-rooted indigenous communities that cannot move any distance to keep up with range shifts of culturally and economically valuable species. As they have done so often in the past, indigenous communities will need to practice a kind of cultural "resistance": that is, the intensive *in situ* management of species upon which communities are dependent.

The restoration of habitat and landscape connectivity is, in certain cases, a relatively inexpensive and readily available tool for increasing the adaptive capacity of endangered species and diminishing the deleterious consequences of climate change. Improving the quality of the landscape matrix by establishing dispersal corridors, creating stepping stone habitats, and expanding the size of core ranges not only confers benefits to sustainable human livelihoods but is also essential for the continued survival of many rare species in the face of climate change (SER 2008b).

Linkages with conservation reserves and wildlife refuges that are rich in biodiversity serve to "increase opportunities for adaptation of protected area ecosystems to large-scale disturbances such as climate change" (Parks

Canada 2008). Linkages to matrices (e.g. resource extraction areas) surrounding conservation reserves and protected areas should be established by restoring and/or conserving stepping stone habitats that provide both dispersal corridors and refugia. The magnitude and rapidity of climate change disruptions requires the expansion of natural areas since reserves are not in themselves able to provide sufficient habitat to accommodate these changes.

Adaptive management techniques, which attempt to address the uncertainties of climate change, sea level rise, and other unforeseen stressors, are now an integral component in the planning, implementation, and monitoring of many ecological restoration projects (SER International 2005). Specific guidelines, based on current information, are indicated in order to direct future responses that enhance the ability of species and habitats to cope with uncertain or variable outcomes. There is evidence that the poleward, upward, or inland shift of endemics will be accompanied by highly competitive non-natives or other endemics. Today, most ecological restoration projects include an aggressive invasive species management component that attempts to control exotics and undesirable endemics until targeted natives can reestablish themselves.

POLICY RECOMMENDATIONS

Ecological restoration is now generally regarded as essential not only for conserving biodiversity but also for promoting economic development and sustainable livelihoods, particularly in the developing countries (SER 2004b). Likewise, restoration within and around degraded ecosystems provides a powerful tool for maintaining or increasing resilience and connectivity in natural environments, thereby reducing the vulnerability of these ecosystems and their resident biodiversity to the projected consequences of climate change. This is especially important in ecosystems with strong and steep ecological gradients, as these areas are particularly at risk.

The Society for Ecological Restoration International (SER) is dedicated to preventing regional and global extinctions, and strongly discourages policymakers from “writing off” species because the technological or scientific knowledge to save them is not immediately apparent. By employing restoration projects in efforts to ensure connectivity at selected sites where the impacts of climate change are likely to be particularly severe, governments, communities, corporations and NGOs can increase the chances of conserving rare species and biotic communities locally while also helping to address the urgent need to develop practical experience and expertise in the use of ecological restoration methods for wider application.

It is essential that reserves are increased in size and connected to other reserves within the context of increased ecosystem function and structural complexity at the landscape scale in order to safeguard biodiversity against the uncertainties of climate change. This can be accomplished by taking into account the biophysical constraints and opportunities within the ecosystems under consideration, and through the re-integration of nature with societal values and traditional practices. We thus urge policy-makers, business leaders, funding agencies, and local administrators to increase investment in long-term restoration projects, especially those where multiple benefits can be obtained (e.g. ecological, social, and economic). These projects can and should be seen as part of the global society’s response to the ecological and economic consequences of ecosystem degradation, global changes, and the loss of biodiversity (European Communities 2008).

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SER International is a non-profit organization infused with the energy of involved members -- individuals and organizations actively engaged in ecologically sensitive repair and management of ecosystems. Our mission is to promote ecological restoration as a means of sustaining the diversity of life on Earth and reestablishing an ecologically healthy relationship between nature and culture. The SER International Science & Policy Working Group promotes excellence in research and contributes to the policy dialogue on ecological restoration as a conservation tool. The Working Group is composed of:

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