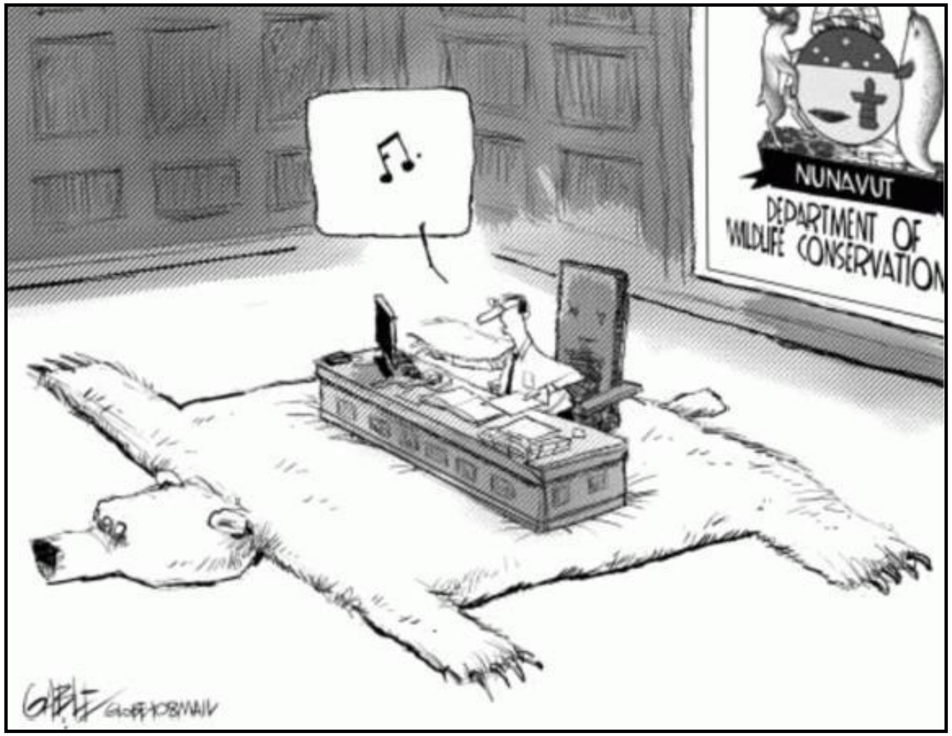
Conservation Strategies



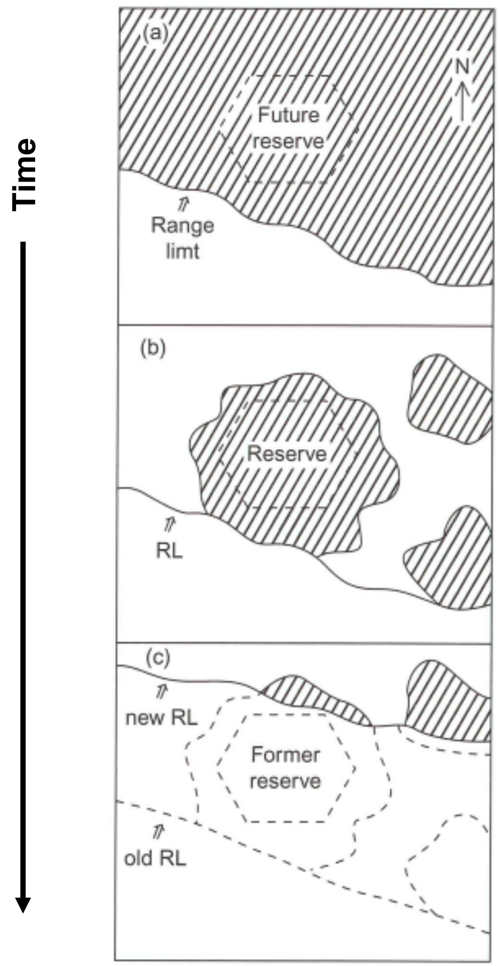
Sometimes, symbolic gestures are important

Protected Areas

Protected areas are a critical component of strategies to provide safe haven to species in the face of climate change.

They must be used in conjunction with *connectivity* and *species management*.

Protected Areas and Species Ranges

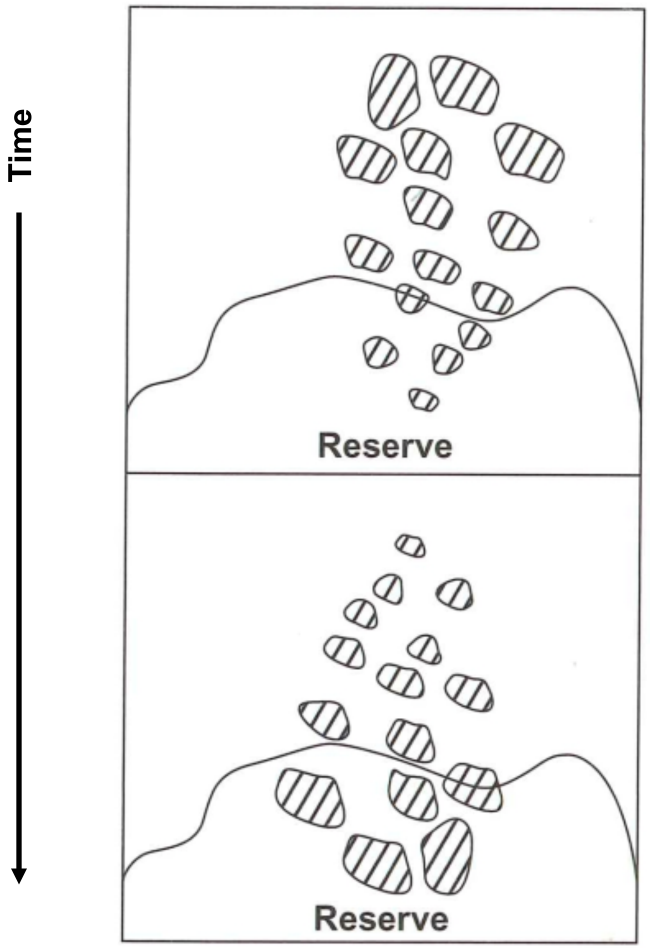


One of the problems with using protected areas to provide haven from the effects of climate change is that species ranges shift.

Many species, confronted by increasing temperatures either move upslope or poleward.

Classical studies examined how this could negatively impact species with reserves that once protected the species being completely outside a shifting species new range.

Protected Areas and Species Ranges



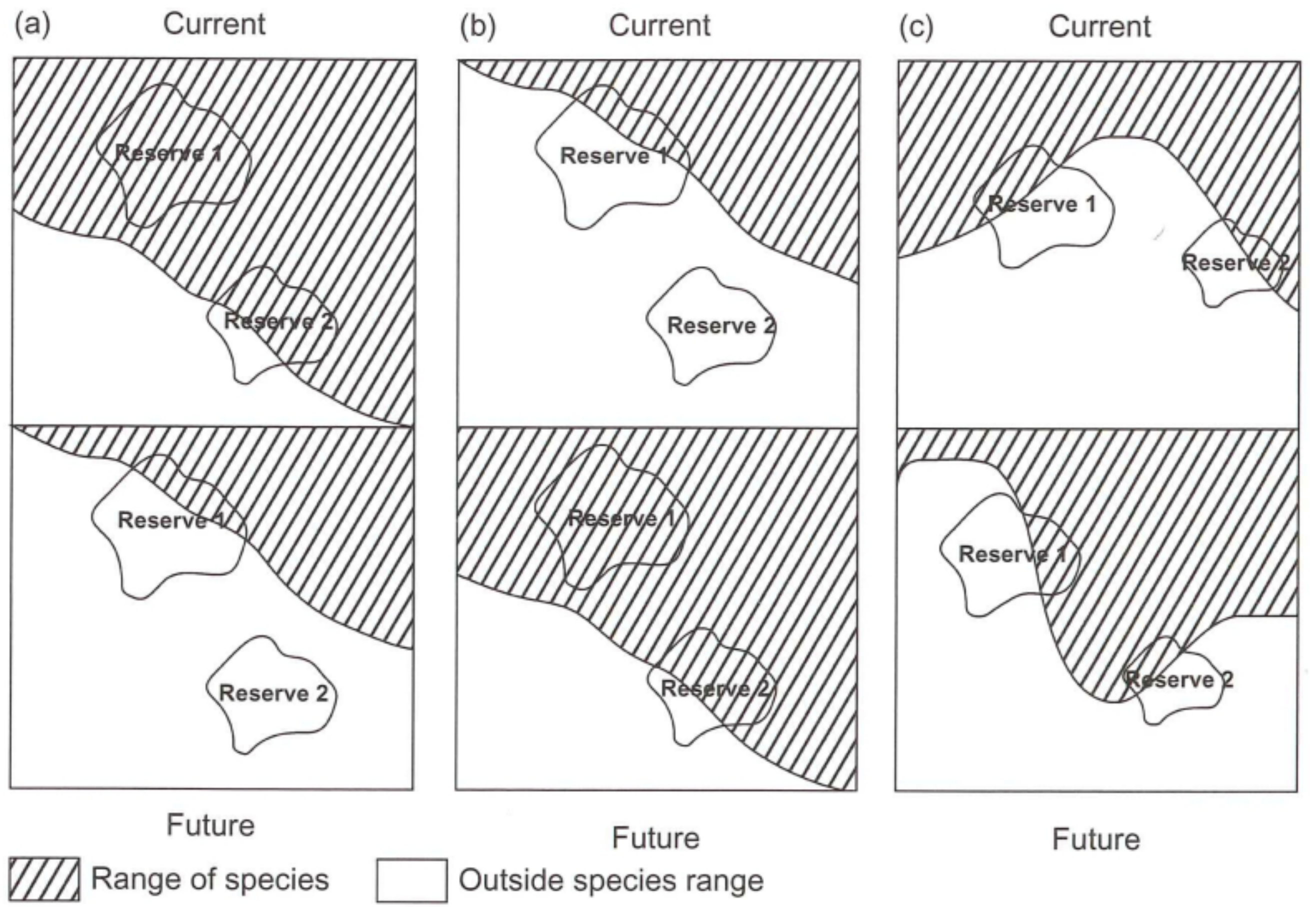
A more reasonable representation would use a metapopulation representation.

It would also allow for dispersal from sites that were becoming inhospitable.

In the depiction, the relative size of segments of the metapopulation within a well-planned refuge would likely increase as individuals sought haven there.

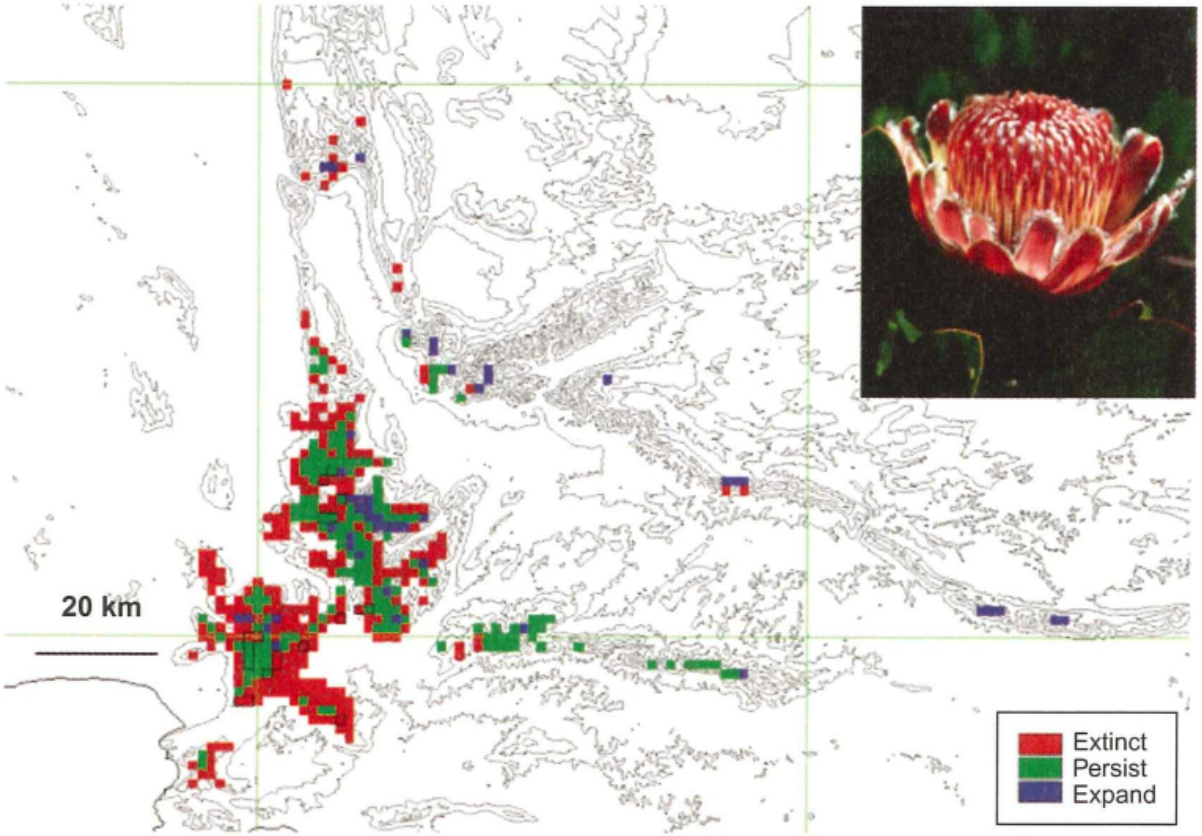
For example, it would make sense to place a reserve more upslope to offset needs to escape increasing temperatures at lower altitude.

Protected Areas and Species Ranges



Planning multiple protected areas to account for future shifts makes even more sense.

Protected Areas and Species Ranges



For many terrestrial species in the southern hemisphere, poleward shifts are not possible and plans have to include upslope shifts and place protected areas accordingly.

Protected Areas and Species Ranges

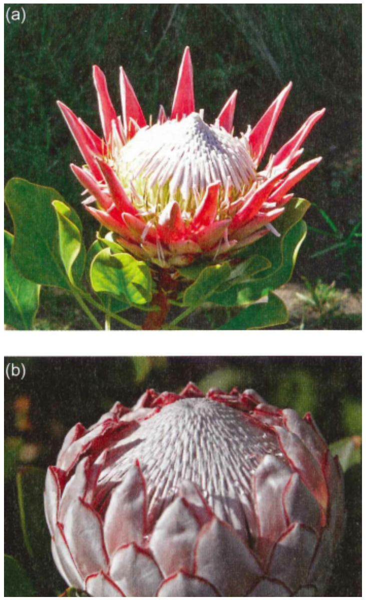


Table 13.1 Decrease in Species Representation in Protected Areas in the Cape Floristic Region Due to Climate Change[a]

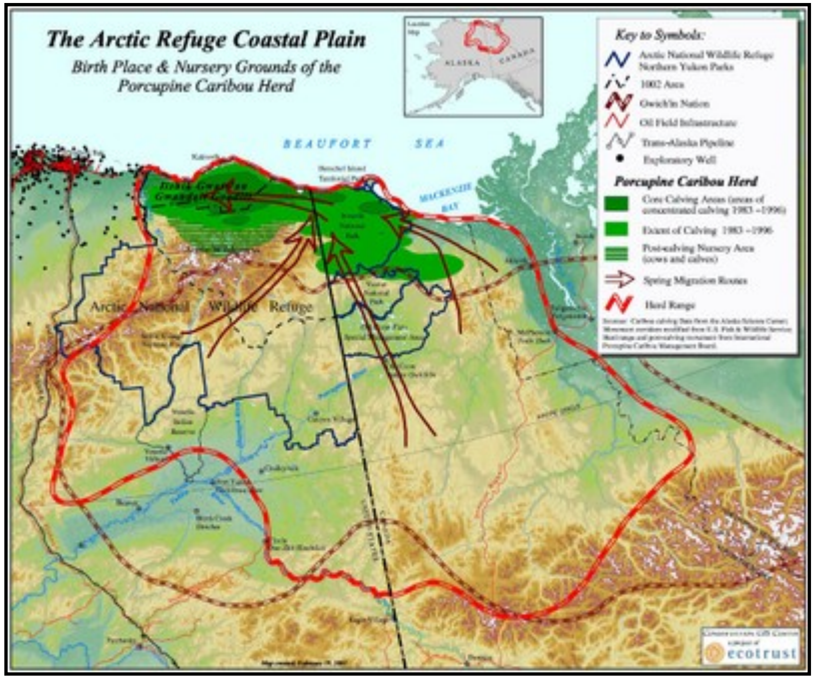
Year (Threshold)	No. of Species (% Decline Since 2000)	
	No-Dispersal Assumption	Maximum-Dispersal Assumption
2000 (presence only)	327 (0)	—
2050 (presence only)	277 (15.3)	301 (8.0)
2050 (100-km^2 minimum threshold)	202 (38.2)	243 (25.7)

[a]The number of species whose modeled ranges intersect protected areas in at least one grid cell (presence only) or at a minimum threshold of area (100 km^2) are given relative to two dispersal assumptions about species' ability to occupy newly climatically suitable areas.
Source: Hannah et al. (2005).

Even with good planning, some species will move out of protected areas and some may move in.

The relation is dynamic but on the whole, fixed location protected areas are projected to provide safe haven for decreasing numbers of species.

Planning for Persistence: Pattern and Process

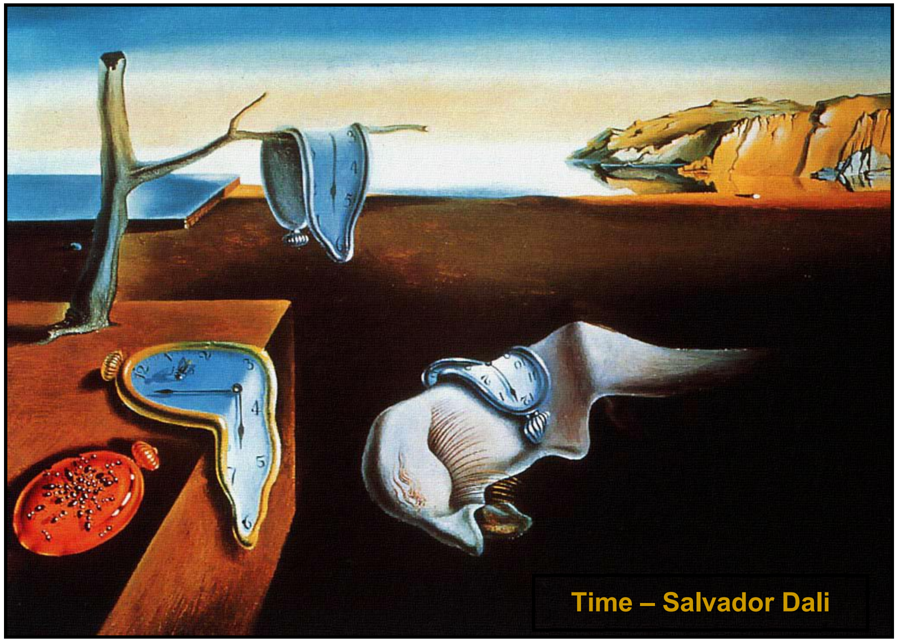


Planning for pattern sets aside habitat used for primary species' use such as wintering or calving habitat for the porcupine caribou herd.

Planning for process sets aside habitat for more ephemeral activities such as the herd's twice annual migration.

A challenge in this example is the fact that summer range has already moved as "poleward" as possible.

Irreplaceability



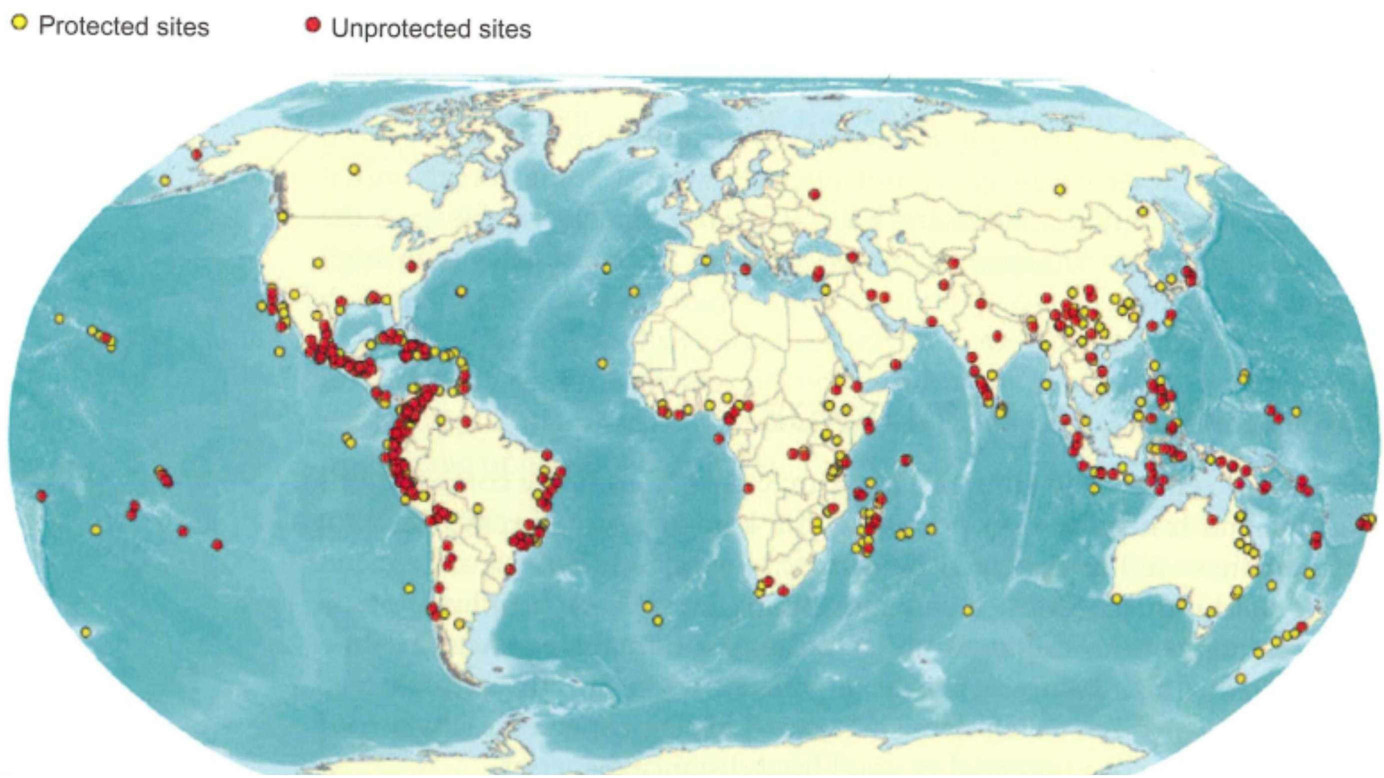
Many of the world's most threatened species are endemics, existing only at a single site.

In many respects, such species, like rare paintings, are irreplaceable and special measures are taken to increase the likelihood of persistence.

Often, such species co-occur in hotspots of endemism and it is easier to justify the extreme costs of well-planned reserves since the public gets many species for its investment.

While irreplaceability is an important criteria, the success rate of protecting such species from the impact of climate change is not high.

Irreplaceability



There are many sites containing at least 1 species that solely occurs there and most of them are not protected.

If climate change alters the conditions past the allowable envelope of those species, extinction is certain.

Preserving Resistant and Resilient Species and Ecosystems

A *resistant species or ecosystem* tends not to be seriously damaged when exposed to a climate change stressor.

A *resilient species or ecosystem* tends to recover quickly when the stressor is removed – even if temporarily and annually.

Resistant ecosystems are generally rich in redundant trophic web connections and balanced feedback systems.

Resilient ecosystems are rich in r-strategic species and have healthy seed beds.

There is a much higher rate of success when priorities focus on these characteristics.

Designing and Managing Protected Areas

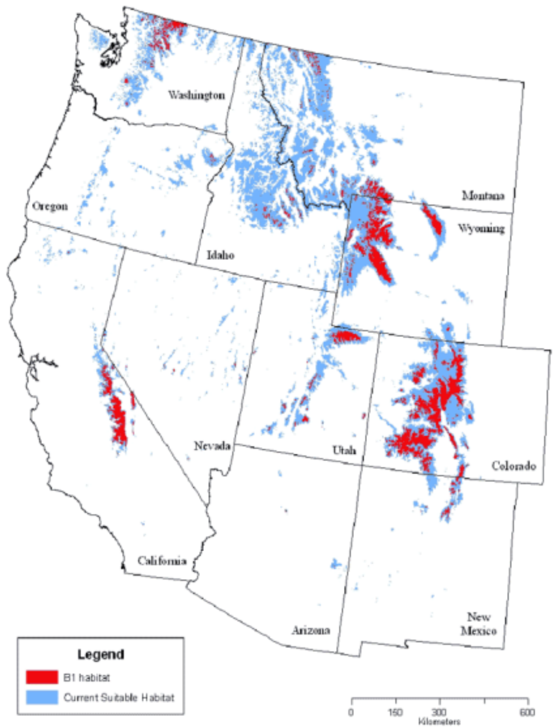
In many respects, designing and managing to mitigate climate change is a game of second guessing nature.

Increasing temperature is not the only "enemy" as flood and drought can be just as devastating to species and ecosystems.

Many protected area reserves are planning for these eventualities by installing water control structures and creating large water impoundments.

These can be used to reduce impact of both flood and drought – situations that seem to be oscillating more extremely and frequently.

Second Guessing Future Species at Risk

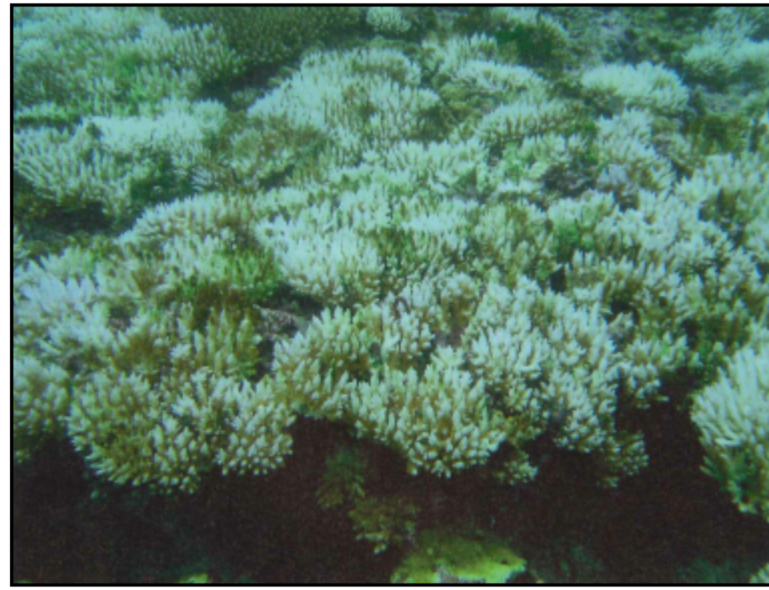


In many cases, species that are still “safe” may suddenly become threatened and need immediate management.

The pika is a good case in point as it has already retreated to high elevation alpine meadows.

Even modest CO_2 increase scenarios (IPCC B-series) substantially reduce available habitat by 2050.

Marine Protected Areas



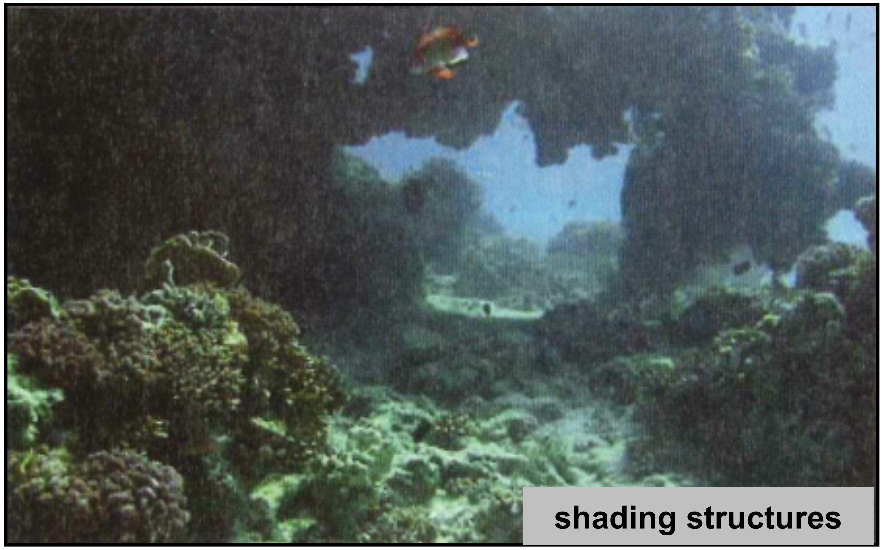
A major goal of MPA's is to prevent healthy coral ecosystems from becoming bleached and barren.

Because increasing temperature and acidity are difficult to prevent, the primary strategies are to focus efforts on coral reefs that are more resistant and resilient and to mitigate other stressors.

Protecting reefs in areas of cooler up-wellings can reduce both temperature and acidity problems.

Centering efforts on previously bleached but recovered reefs takes advantage of coral selected for higher resistance and tolerance.

Marine Protected Areas



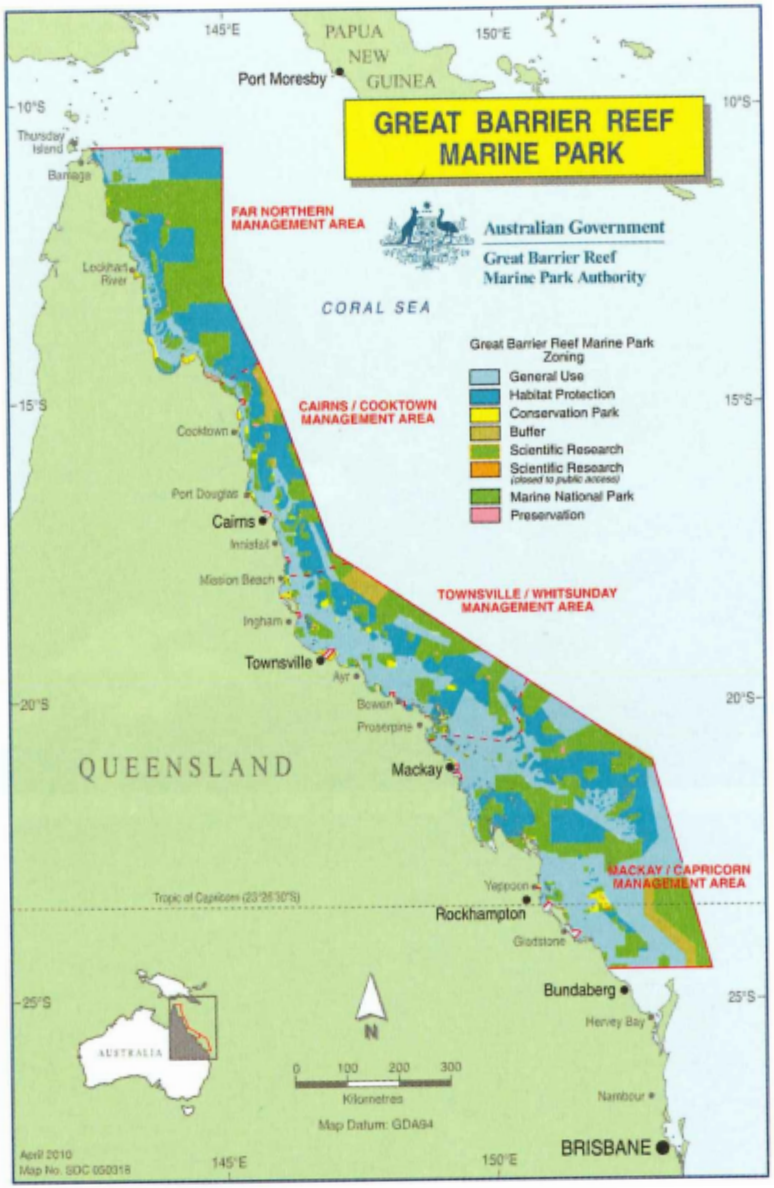
Prioritizing the protection of reefs with features that mitigate the effects of temperature and acidity is another successful strategy.

Reefs in the shadows of mountains are cooler than those that are more exposed.

Reefs with natural shading structures or those with added shading structures are less prone to bleaching.

While high levels of sedimentation are harmful, moderate levels of sediment can actually reduce both temperature and acidity effects.

Marine Protected Areas



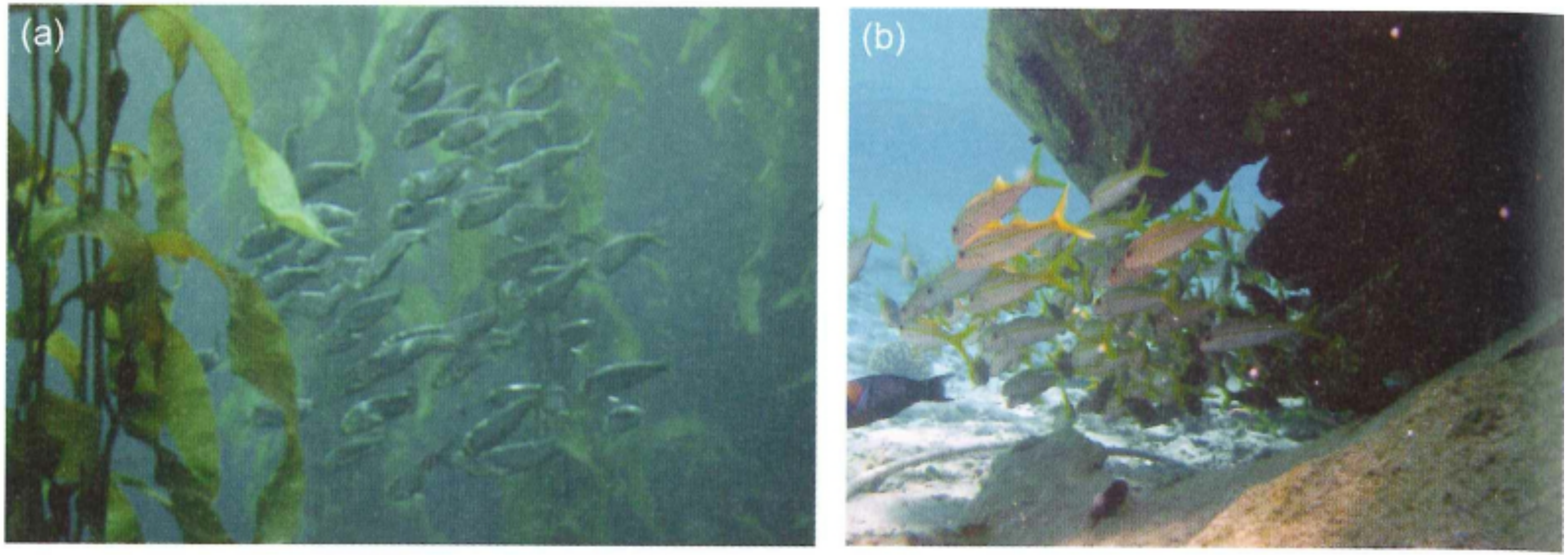
Multi-use zoning of reefs can help mitigate damage and minimize stressors that exacerbate effects of temperature and acidity.

These zones are often switched through time to allow recovery time for some areas but tourism and harvest in others.

Tourism and some extractive activities are necessary to support the MPA and to maintain awareness.

Tightly integrated educational and public relation programs are also required.

Marine Protected Areas



Alternating extractive and tourist operations with each other and with periods of complete “off-limit” recovery allows for a recovering coral reef to reestablish a healthy local ecosystem

This can occur faster in marine ecosystems since completely closed areas serve as a refugium for species dispersing from nearby exploited portions of the managed protected area.

Marine Protected Areas

As ice cover is reduced in polar regions there are extreme changes in the ecosystem.

The recession and dissolution of pack ice allows development of a water column ecosystem that reduces the detritus falling to the benthic (bottom) region.

As a consequence, the benthic community has shifted from predominantly molluskan to a more echinoderm rich fauna.

Marine Protected Areas

These are two of the many species that normally feed on benthic mollusks that are now disappearing.

The recession of the ice also means these species, who normally rest on the pack ice, are spending more time in cold seawater where thermal losses are greater.

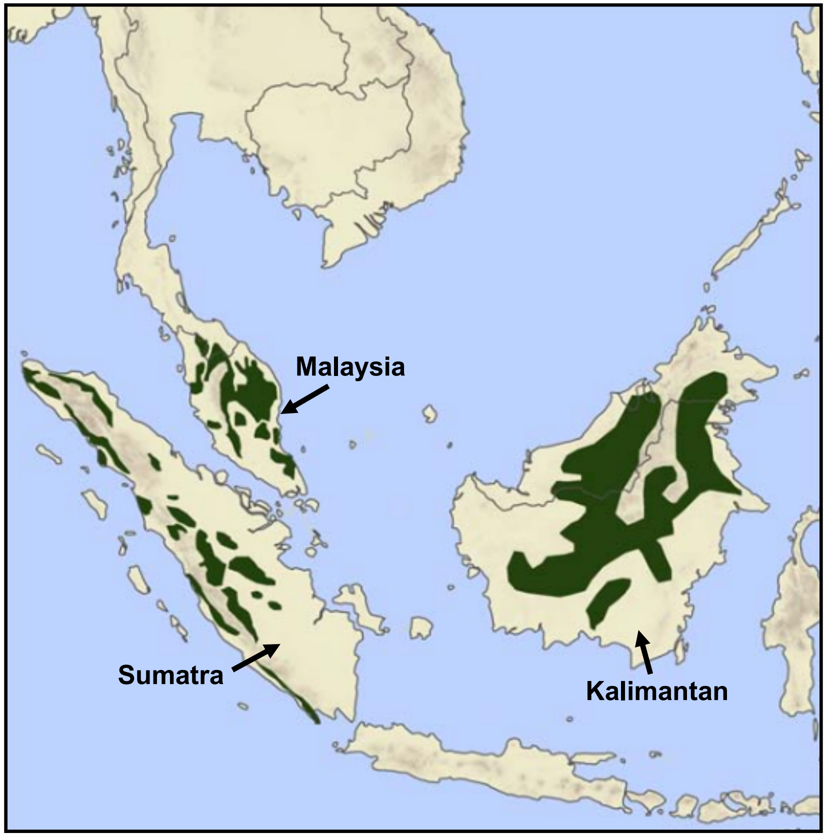
If they stick with the receding sea ice, they find themselves in deeper water where the benthic molluskan community is more depauperate and more difficult to reach.

MPA's that provide safe haven for traditional benthic communities must be a priority.

Considerations for Protected Areas for Climate Change

Site planning	Climate evidence explicitly incorporated through scenario-building
	Multiple time horizons to represent uncertainty and possible long-term future conditions
	Refinement of regional scenarios
Management actions	Coordinated with other reserves in region
	Planned using scenarios of climate change and Range shifts
	Based on iterative monitoring feedback
Monitoring	“At-risk” species (from climate change evidence, threatened species, management targets)
	Structured, taxon-stratified sample of all species
	Enhanced collection of climate/weather data
	Biotic survey
	Iterative feedback to management planning and action

Connectivity and Landscape Management

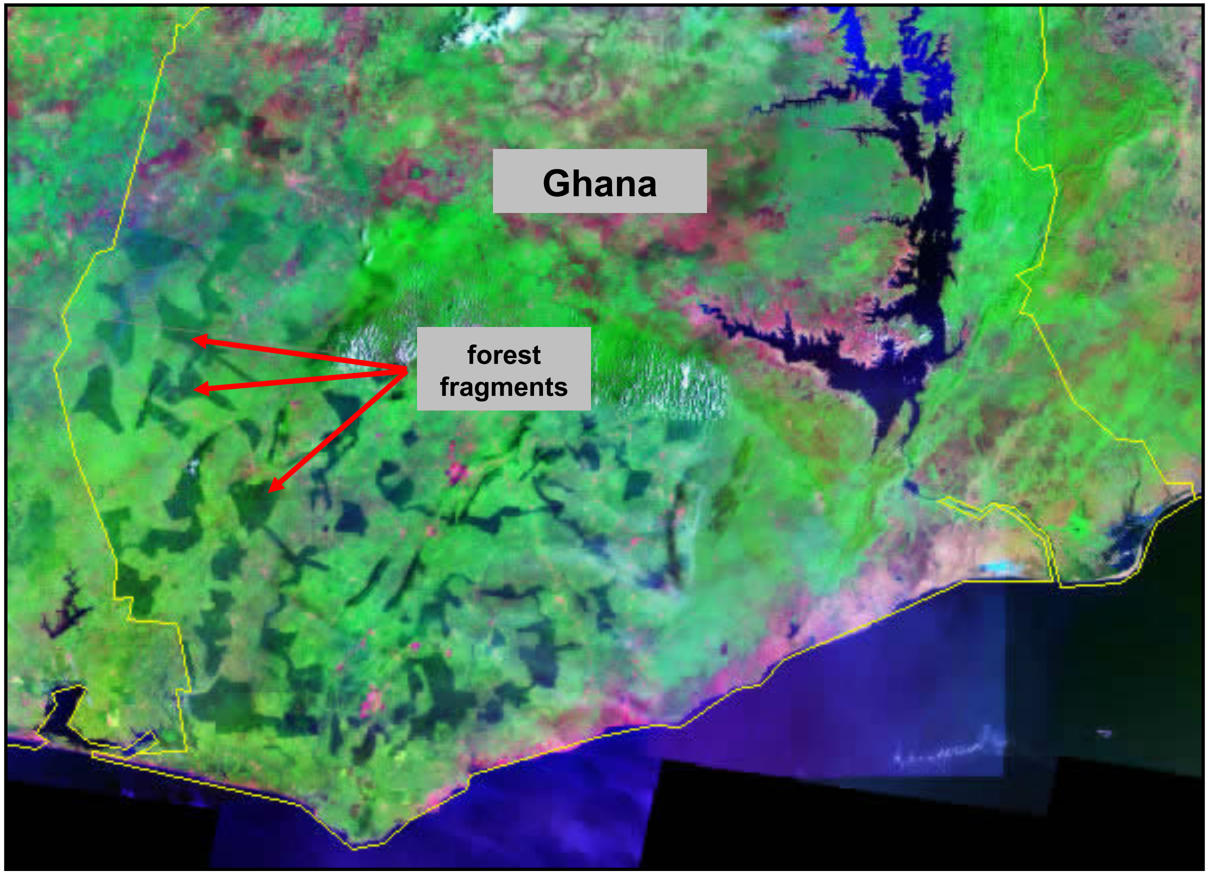


Flat-headed cat
Prionailurus planiceps

A 5-6 pound, nocturnal predator of fish.

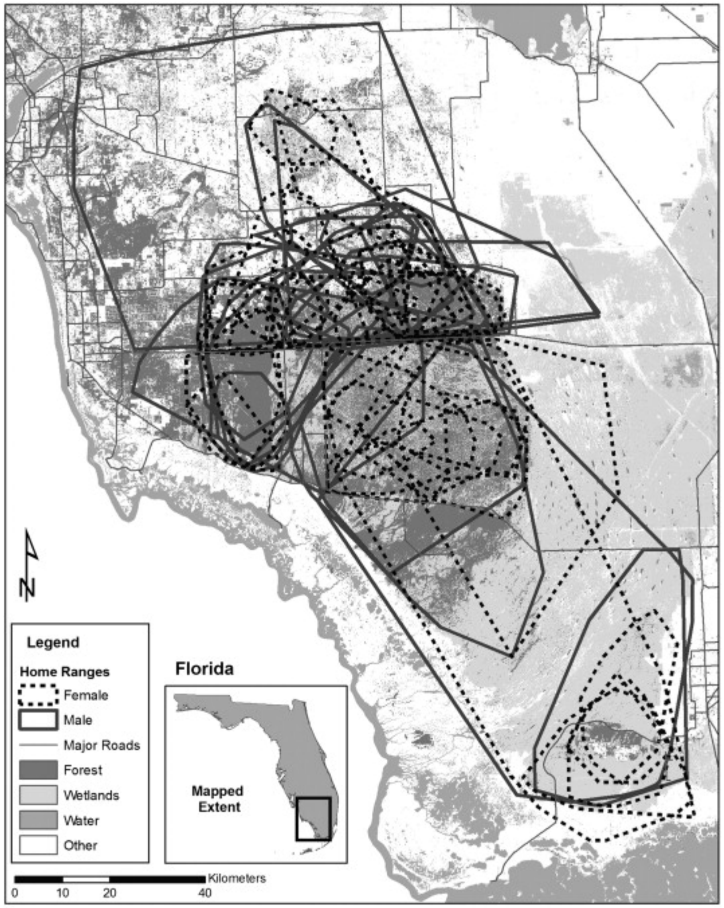
As habitat is lost to cultivation of oil palm and other crops, it is only connectivity of shrinking habitat that keeps the world's rarest felid from extinction.

Connectivity and Landscape Management



In much of the developing world, which are also endemism hotspots, the remaining habitat that could be sequestered for reserves is so fragmented, it is not clear that connectivity corridors can even be established.

Area-Demanding Species



Florida panther (*Puma concolor coryi*)

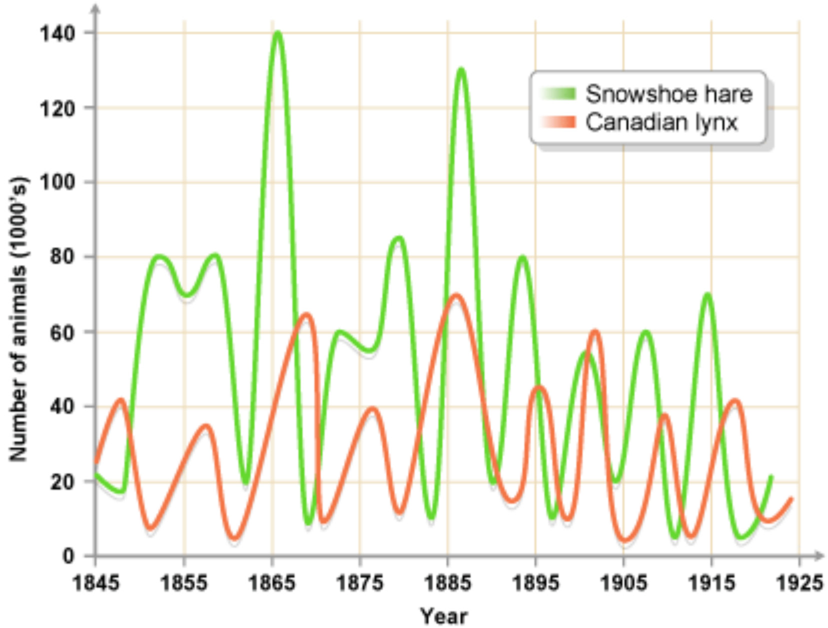
This 130 pound 6.5 foot long predators feeds on small mammals and birds.

Its home range far exceeds available habitat and it persists on by virtue of connectivity corridors.

Reserves to protect species that require large home ranges has to be based on interconnected tracts of suitable habitat.

The corridors have to be preserved and need to avoid areas of human conflict like roads.

Area-Demanding Species

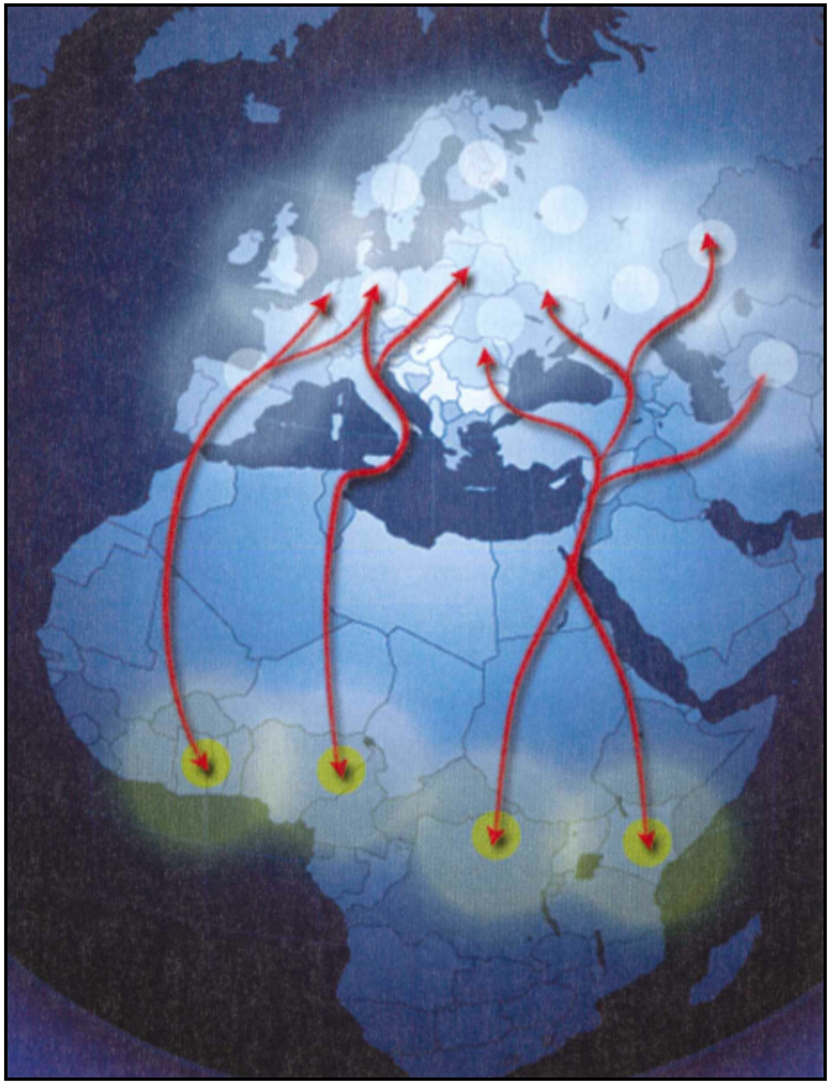


Predator/prey interactions lead to stability of the ecosystem and this is even more the case when factors such as food availability tend to increase or decrease prey abundance.

When planning for management of area-demanding predators, reserves must be large enough and planned in such a way that climate-change-based shifts in predators and prey match.

Without predator control, herbivorous prey increase and begin destroying the plant community ultimately leading to a trophic cascade.

Migratory Species



Migratory species pose a second type of challenge in planning reserves to offset the impacts of climate change.

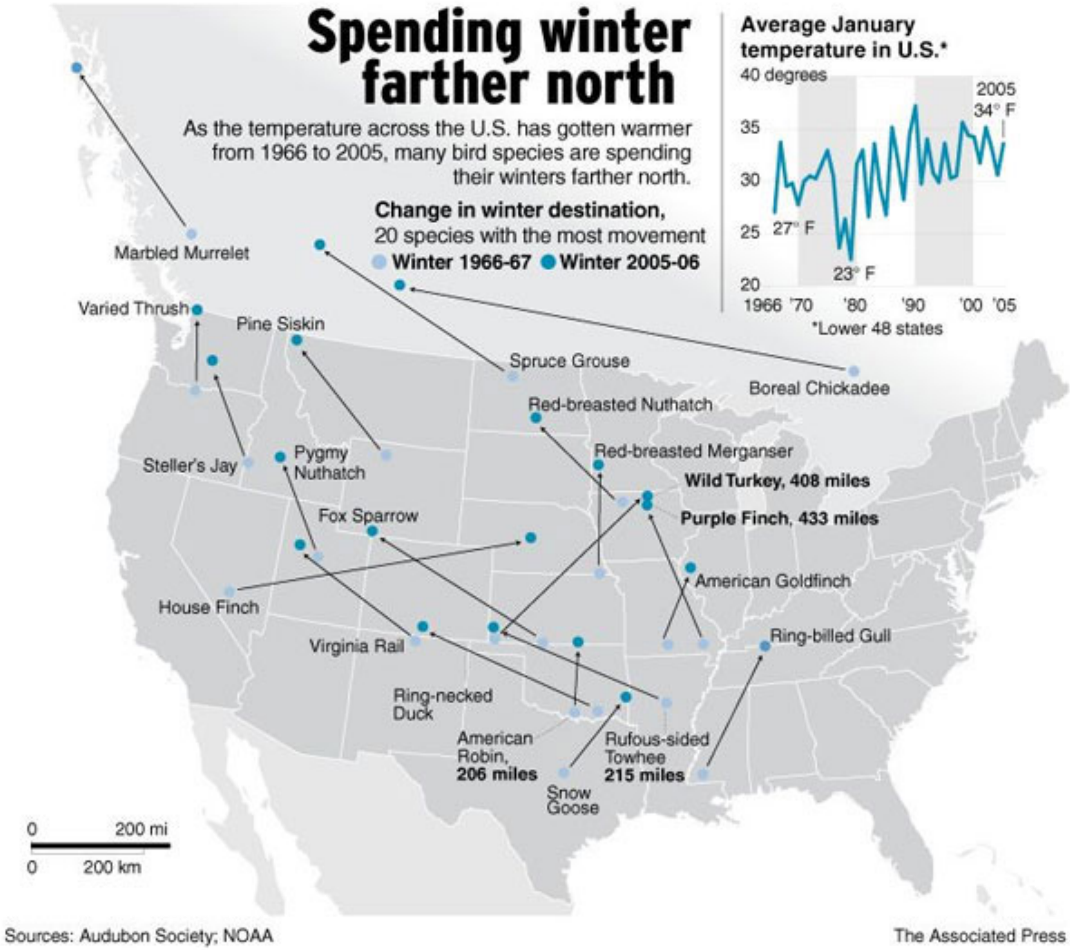
Provisions have to be made to meet both summer and winter habitat needs.

Migration corridors must also be preserved to make sure the migrants can find both suitable habitat and adequate nutrients.

Many species of migratory geese “ride the green wave” of productivity moving north.

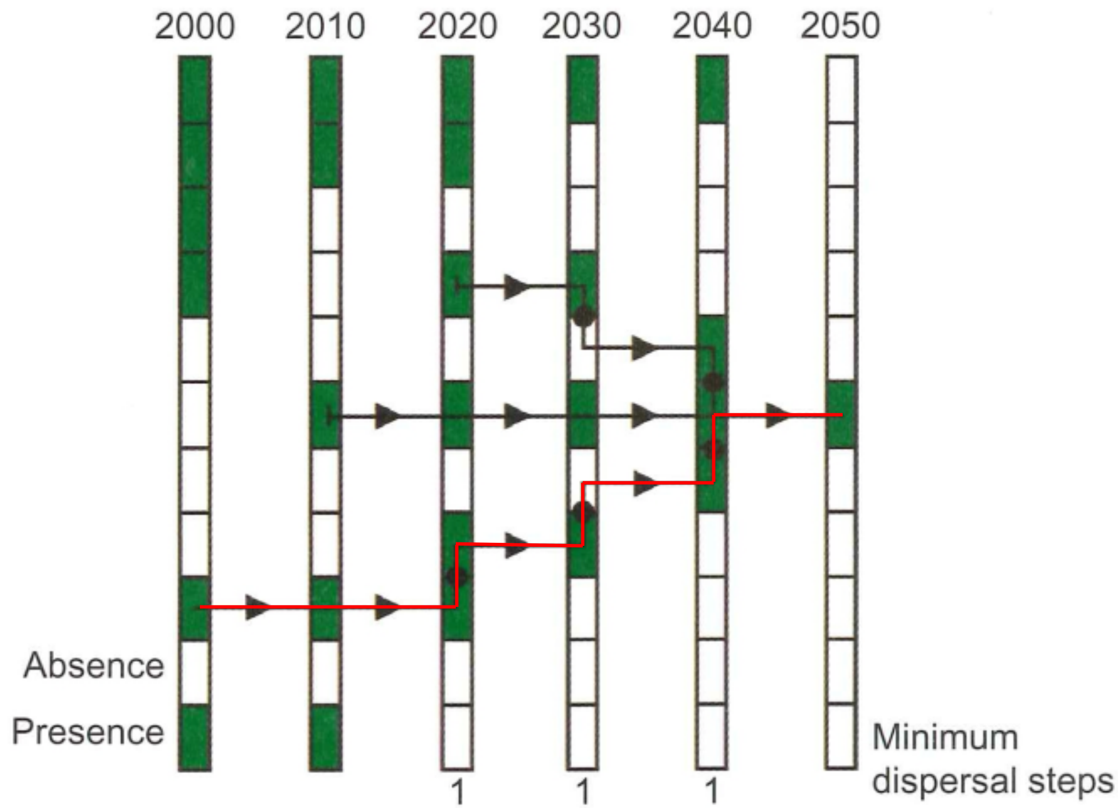
Climate change is altering plant phenology and to remain successful, the geese must alter their migrations accordingly.

Species Range Shifts



As these range shifts occur, connectivity corridors must be preserved to allow the species to shift to new habitat.

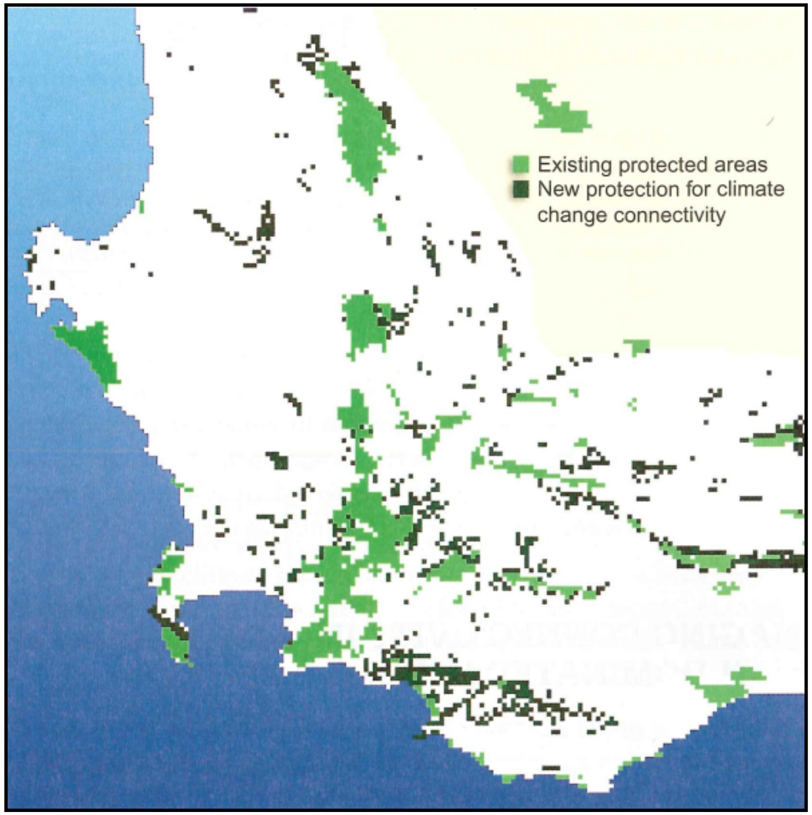
Planning for Connectivity



Fine scale needs can be visualized as chains linking current suitable habitat to future suitable habitat.

In the visualization, only the red chain actually connects 2000 to 2050.

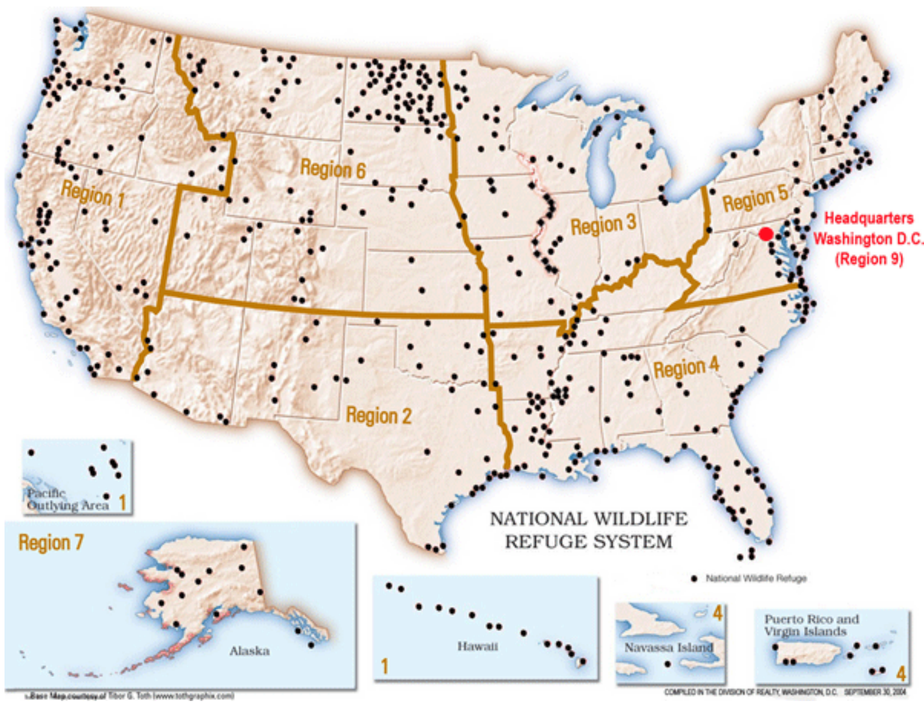
Planning for Connectivity



Integrating corridor habitat with habitat planned for climate induced range shifts is a cost effective form of landscape management.

In this design for numerous species of *Proteus* the attempt is to acquire upslope habitat for more permanent reserves coupled to corridors allowing for range shift.

Regional Coordination



Much of the National Wildlife Refuge System was designed to provide safe haven for migrating ducks and geese moving between summer nesting and winter foraging habitats.

The refuges contain water control structures and reservoirs to handle droughts and floods.

Habitat is managed to provide food and cover for migrating birds.

While originally targeted for harvestable species, they provide safe haven for much of North America's avifauna.

Management of Species at Risk

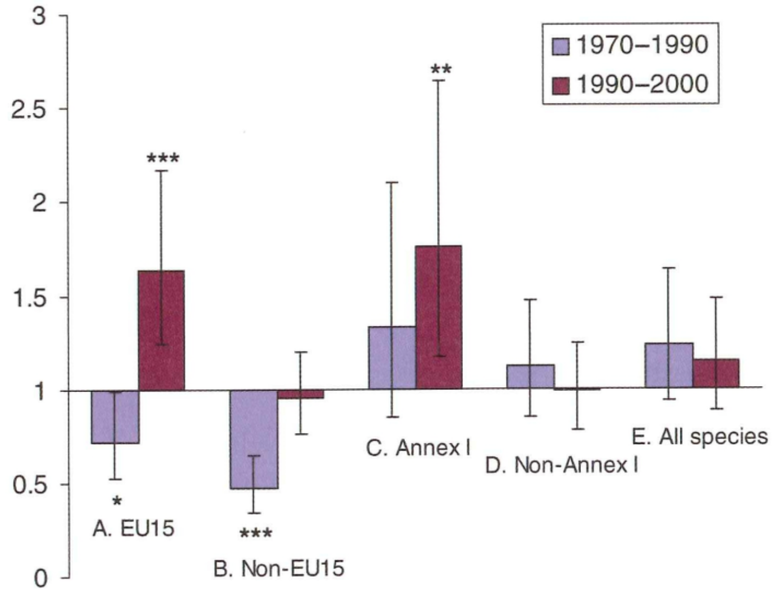
When protected areas and connectivity cannot adequately conserve a species, directed management to prevent extinction is called for.

This can involve: removing other stressors, *in situ* management, assisted migration and rescue (*ex situ* management).

Threatened Species

In the US, threatened and endangered species are defined and protected under the Endangered Species Act that sets out criteria for listing and mandates actions that have to be taken to mitigate responsible threats.

In much of the world, there are no such formal laws although the International Union for the Conservation of Nature (IUCN) maintains a list of all threatened and endangered species.

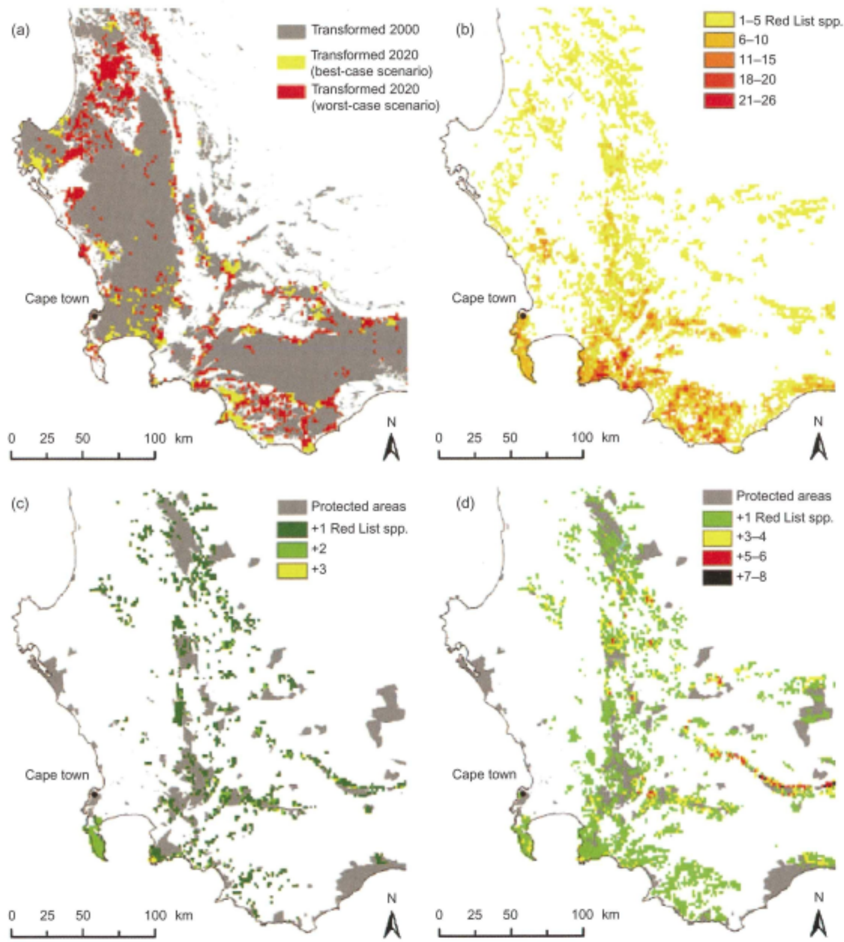


The European Union Birds Directive that lists species at risk and provides encouragement and advice aimed at improving the plight of such species.

Even without enforceable laws, the EU Bird Directive has affected improvement for European bird species.

Exacerbating Effects

Increasingly, habitat is being transformed for human use.



Current species at risk closely track the transformation of the landscape

The increase in land transformation will result in additional species at risk.

Climate change and land transformation combine to result in even more species at risk.

Species stressed by loss of habitat and other anthropogenic factors are “pushed over the edge” by the impacts of climate change.

Species Threatened by Climate Change

All species of sea turtles are threatened by overharvest (for making soup for gourmets) and as by-catch of fishing trawlers.

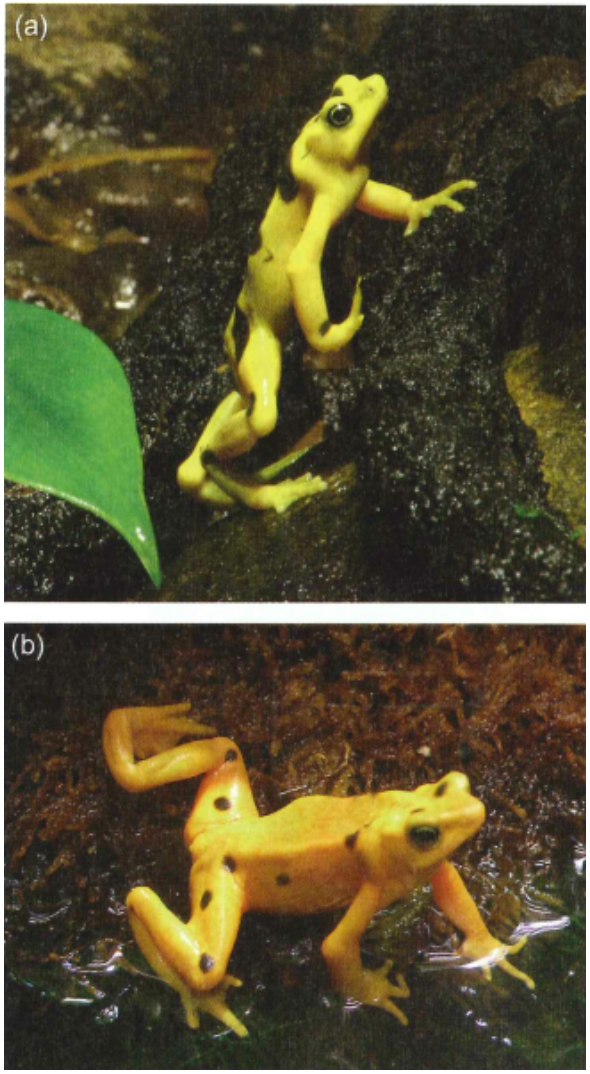
The newest threat is from climate change.

Increased temperatures in polar latitudes is melting major land-based ice and this is raising sea levels.

It will not take much rise before the sand beaches used for egg laying will be inundated.

Eggs must be laid and allowed to hatch above the high tide line.

Species Threatened by Climate Change



The disappearance of toads in the genus *Atelopus* in Central and South America is due to the negative interaction of climate change based changes in temperature and moisture and a chytrid fungal infection.

Amphibians globally are especially vulnerable to such interactions as moisture is key to maintaining a barrier to infection.

An Iconic Example of Poor Procedure and Policy

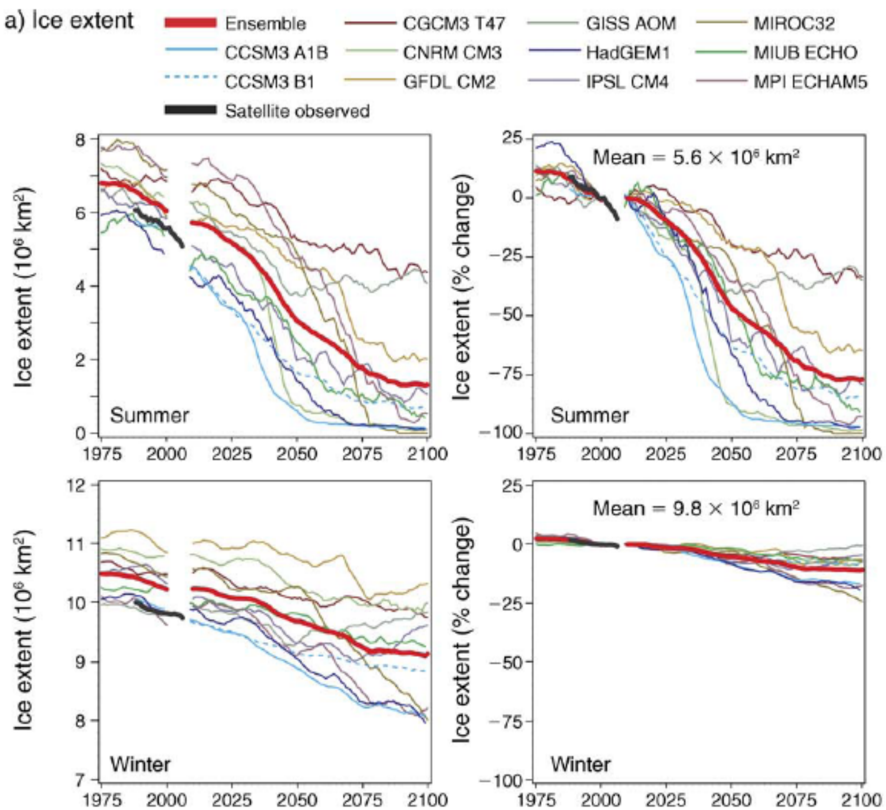
There is little doubt that an apex predator in a labile habitat should be given special protection.

Normally, listing under the endangered species act (ESA) requires a significant decline in abundance over a fixed time period or a sustained reduction in population growth rate.

Unfortunately, responding more to advocacy than science, the US government has listed the polar bear as threatened in Alaska.

This action, and subsequent twisting of provisions of the ESA fails to provide the protection needed and undermines the entire listing process.

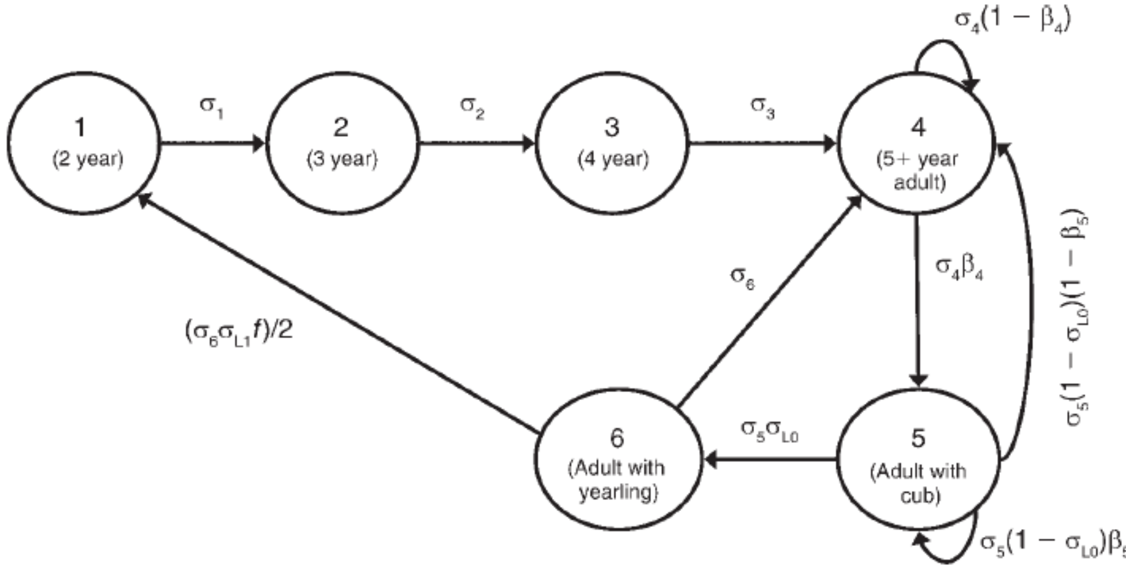
An Iconic Example of Poor Procedure and Policy



Under a variety of IPCC scenarios, General Circulation Models project that the extent of sea ice in the Beaufort Sea (off north coast of Alaska) will decline in summer and winter through 2100.

The precise extent varies across the scenarios and the modelers used an ensemble (average) value for further work.

An Iconic Example of Poor Procedure and Policy



They developed a projection model for polar bears in the Beaufort Sea Population and parameterized it with life history values that varied with the extent of sea ice.

They assumed that the statistical relationships they had established from a 10 year data set were applicable over a 100 year time span that include ice extent projections that were mostly outside the range of values used to establish the projections.

Their projections showed the growth rate of this population would fall below $\lambda=1$ by 2050.

An Iconic Example of Poor Procedure and Policy

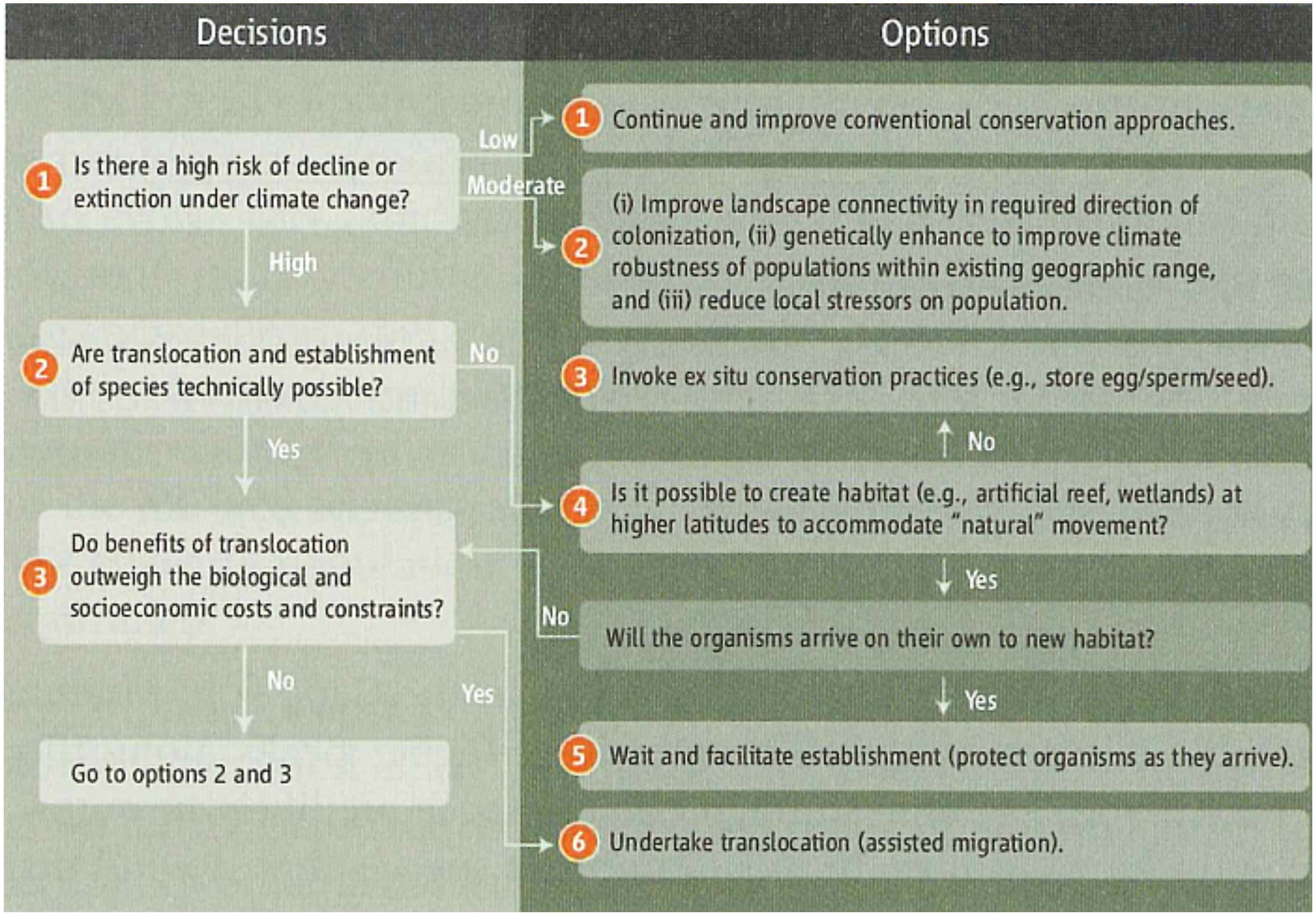
Based on these projections, rather than actual demonstrated declines, the polar bear was listed as threatened.

While using projections is a step in the right direction, these projections are questionable as the ignored peer-review pointed out.

This sets a bad precedent.

Worse, the Bush administration exempted the government from having to mitigate the cause for the listing – greenhouse gas emissions.

Confronting the Problem



Minimize Non-Climate Change Stressors

Many species are negatively affected by human activities.

These effects may exacerbate the projected impacts of climate change and put increasing numbers of species at risk.

Reducing those stressors will increase the likelihood that species will be able to withstand the effects of climate change.

in situ Management

Kirtland’s warbler is a bird of jack pine forests found in southeastern North America.

It specializes in young and highly productive trees found in openings produced by periodic fires.

Climate change is causing jack pine forests to grow more rapidly and produce thick, dense stands that are not suitable for Kirtland’s warbler.

Managing for this critically endangered species requires periodic controlled burns of the forest to produce early successional stands.

Assisted Migration = Translocation

Polar bears finally migrate to Antarctica

If exacerbating stressors can not be removed and the habitat can not be “fixed”, it is conceivable that the species can be “saved” by moving it to another location with suitable habitat and resources.

The translocated species must be sufficiently fit and flexible to succeed at the new location.

Care has to be taken that the translocated species does not have a negative effect on other species in the new location.

ex situ Management

When all else fails, remnants of the species are removed from the wild and placed in facilities where attempts are made to establish a breeding population.

Releasing captive-reared individuals into the wild is always a stated goal of these programs.

The first obstacle is finding an appropriate release site – as with translocations.

The second is that captive-reared individuals are often inbred, selected for non-natural conditions and ill-equipped to fend for themselves.