Trees on the Move? Debating Assisted Migration in Climate Change Mitigation

By Sarah Bisbing

Trees on the move?! I know you’re thinking, “Come on, Sarah. Trees can’t move.” And, generally, you would be correct in that statement. Tree species are now, however, in a position where movement may be necessary for survival under changing climatic conditions. How trees will move is under debate within the ecological community, but why trees will move is accepted as a survival strategy related to the adaptation of species.

Species are adapted to specific combinations of environmental and climatic conditions. These specific conditions produce suitable habitat and enable a species to grow, thrive, and reproduce. When these conditions are altered, as is currently occurring amidst our rapidly changing climate, species are often left exposed to novel, unsuitable habitat conditions. Species are then forced to either get used to the new conditions (adapt) or move (migrate) to areas where suitable habitat still exists. The alternative to these
strategies is, at best, population loss or, at worst, extinction.

Adaptation aside, migration and tracking of suitable habitat remain the next best option. But, as we discussed above, some species are virtually incapable of moving. Forest trees are long-lived and immobile, meaning they don’t move that far and when they do it isn’t done that quickly. Migration rates following the last ice age are estimated at a pace of around 100 meters per year. To keep pace with shifting climate and regenerate under suitable habitat conditions, trees will need to migrate at a rate upwards of 10 kilometers per year (that’s a migration rate 100 times faster than previously-documented!). Consequently, all tree species are expected to experience lags in their response to changing climate. If, as predicted, these migration rates cannot be met, how else can tree species move to keep up with the pace of shifting habitat?

One proposed strategy is the human-aided relocation of species (known as assisted migration), but this concept is one of the most controversial, divisive debates within the ecological community. A recent review on the topic (Hewitt et al., 2011) found that 60% of published articles are generally supportive of considering assisted migration, while 20% stand in opposition and 20% remain undecided. As with every story and every debate, this conversation has two sides to it. Each side stands firm in their position on human-aided assistance of species’ migration. Supporters (Hough-Guldberg et al., 2008; Gray et al., 2011, Camille Parmesan) argue that inaction will inevitably lead to extinction, while critics contend it is guaranteed to produce unintended, unpredictable consequences (Ricciardi and Simberloff, 2009).

Where do YOU stand on assisted migration?

Do you know both sides of the debate? Do you have the facts? Before you respond, let’s make sure you have all the information you need to make an informed decision. I do not intend to take a stance here but rather write this as a means of sharing available information.

Assisted Migration 101

Assisted migration is the movement of species within or beyond their historical range, implemented to conserve species and facilitate adaptation to predicted climate change. This term is often used interchangeably with assisted range expansion, assisted colonization, or managed
relocation. The strict definitions of these terms are nuanced – although slightly different, each one describes the human-aided movement of species. **Bottom line** = we’re talking about physically moving a species from its current habitat to another habitat (presumably to areas that will encompass future suitable habitat conditions). Let’s leave it at that.

Here are some of the arguments for and against this proposed practice:

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Risks</th>
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<tbody>
<tr>
<td><strong>For ecosystems</strong></td>
<td></td>
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<tr>
<td>Averting the risk of inaction and loss of</td>
<td>Potential for creation of new invasive</td>
</tr>
<tr>
<td>ecosystem function</td>
<td>species</td>
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<tr>
<td>Preserving ecosystems and communities in rapid</td>
<td>Detrimental effects on local</td>
</tr>
<tr>
<td>decline</td>
<td>communities at transplant site</td>
</tr>
<tr>
<td><strong>For species</strong></td>
<td></td>
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<tr>
<td>Protecting vulnerable species from maladaptation</td>
<td>Potential loss of within-species local</td>
</tr>
<tr>
<td>and possible extinction</td>
<td>adaptation</td>
</tr>
<tr>
<td>Maintaining species may outweigh the risks</td>
<td>Uncertainty in species response and</td>
</tr>
<tr>
<td>associated with inaction</td>
<td>likely unintended consequences</td>
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<tr>
<td><strong>For society</strong></td>
<td></td>
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<tr>
<td>Maintaining ecosystem health and economic</td>
<td>At odds with goal of preserving</td>
</tr>
<tr>
<td>viability</td>
<td>natural ecosystems and processes</td>
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</tbody>
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**Conservation Perspective:**

In the conservation world, assisted migration has, at times, been likened to ‘ecological roulette.’ The major critiques of this action are that it contends with well-established conservation practices and is not yet fully supported by rigorous scientific knowledge. Many argue that increasing landscape connectivity is instead the best option for the movement of species and one that has a much lower probability of unintended consequences (Krosby et al., 2010). Rather than working to manually move species, the ecological community could instead focus their efforts on working with land managers and government agencies to increase the area of protected landscapes and reduce barriers to species movement. Supporters assert that these alternative actions have the potential to increase the adaptive and migratory potential of both species and ecosystems.

Some conservation practitioners, conversely, argue that assisted migration may be the only way to save some species. One compelling argument for human-aided assistance is the mounting evidence suggesting that climate change will be a significant driver of extinction (Parmesan, 2006). Under these circumstances, both landscape connectivity AND direct mitigation actions may be key to species persistence under altered habitat conditions. McLachlan and colleagues contend that assisted migration must be considered if avoiding climate-driven extinction is a priority. Averting extinction may require such deliberate, human-aided range expansion.

The potential for extinction that is associated with inaction must be weighted against the uncertainty and potential consequences of action. Will assisted migration be the best option for the conservation of species, or will we ultimately regret our role in the interference of natural ecosystem functioning?
Management Perspective:

Foresters and land managers worry that the predicted increase in temperatures associated with ongoing climate change will leave tree species maladapted to local conditions. For managers, the permanent, irreversible loss of a species via extinction is just not an option. Species must be maintained to preserve both ecosystem health and economic viability.

In areas strongly dependent upon the timber industry, as is the case in British Columbia (BC), persistence of dominant forest tree species is imperative. Nearly 200 million seedlings are planted in BC each year, with the province relying heavily on these future forests as a source of income. BC has already witnessed some of the detrimental effects associated with a rapidly changing climate, including declines in forest productivity and widespread mortality from insects and disease. As a result, BC has become a world leader in assisted migration research by setting up a large-scale, controlled experiment (known as the Assisted Migration Adaptation Trial) to test the tolerance of forest tree species to climate change. This long-term, province-wide study will quantify the lower and upper tolerances of species over the course of the next few decades. Additionally, researchers are pairing genomic analyses with experimental treatments to identify the genes associated with adaptation to local climatic conditions (AdapTree, UBC Centre for Forest Conservation Genetics).

It’s too early to say whether or not this experiment will support the implementation of assisted migration, but the ball is in motion. Only time and scientific rigor will really tell.

To assist or not to assist?

Regardless of what we decide, we will need to come up with a risk assessment, a set of best management practices, and some kind of decision process for the conservation of species (i.e. a way to decide which species get managed and which are left to adapt on their own).

Few papers lay out our options and their associated consequences, but I did find one that presents a nice, clean outline of action versus inaction. In their 2007 paper, McLachlan and colleagues suggest that we have three strategies to choose from:

1. **Aggressive Assisted Migration**
   - Acting before we have all the facts.
   - Confidence that climate is the main driver of species distributions.
   - Trust in model projections of shifts in climate and suitable habitat.
   - Includes extensive translocation of species well beyond current ranges.
   - Maintaining species may outweigh the risks associated with transplantation.
   - May be the best way to minimize species loss.
But . . . may also lead to disruption of existing communities at translocation point. Consequences may be irreversible.

2. **Constrained Assisted Migration**

- Acting when necessary and supported by science.
- Confidence that assisted migration is necessary despite risks.
- Balance between the benefits and risks associated with assisted migration.
- Action may require proof of imminent threat.
- Full risk assessment and management plan in place.
- Requiring rigorous scientific research, relying less on model predictions.
- Could go either way – despite being more cautious, may still lead to disruption of ecosystems. On the other hand, lack of data may result in inaction and subsequent loss of species.

3. **Avoidance of Assisted Migration**

- No action.
- Confidence that species have persisted despite previous climatic shifts.
- Uncertainty in ecological understanding of controls on species distributions.
- Concern over the unintended consequences of well-intentioned human interference.
- Concern over the potential for these species to become invasive.
- Uncertainty in model predictions of future suitable and unsuitable habitat.
- Instead, preserve isolated populations and increase landscape connectivity to facilitate dispersal.
- But . . . inaction will increase the threat of extinction for species that are sensitive to any change in local conditions.
- Extinction is irreversible.

NOW, what do you think?

Do we work to conserve spaces or conserve species? Will it be enough to conserve natural ecosystems and maintain connectivity between them? Or will we need to actively work to conserve species?

What role should assisted migration play in the conservation of forest tree species? Do we act now? Or do we wait and see?

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In case you’re looking for more information, the body of literature on assisted migration is immense. To get you started, here are a few links:


Minteer and Collins. 2010. Move it or lose it? The ecological ethics of relocating species under climate change. Ecological Applications.
