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Integrating Climate Change into Invasive Species Risk Assessment/ Risk Management

Workshop Report

November 2008

PRI Project
Sustainable Development

Canada

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1. Introduction

The Policy Research Initiative (PRI) held a one-day workshop, *Integrating Climate Change into Invasive Species Risk Assessment*, on March 11, 2008. The goal was to examine how climate change considerations factor into work on invasive species within the federal government, particularly in terms of risk assessment and risk management. Organized in partnership with the Canadian Food Inspection Agency (CFIA), representatives from several federal departments and agencies with regulatory functions attended the workshop. The CFIA conducts risk assessments for invasive alien species in the context of animal and plant health and is broadly recognized for its risk assessment approach. The Agency, however, has yet to incorporate climate change into its work. The integration of climate change into invasive species risk assessment does not appear to be commonplace in most federal processes.

The workshop was designed as a learning event to increase awareness of climate change impacts with respect to invasive species. It gave participants the opportunity to contemplate the value of including climate change into invasive species risk assessment and discuss the issues and challenges that may arise in doing so. The workshop consisted of awareness-building presentations and a case study exercise that allowed for interaction and learning among the participants. The presentations and case study exercise facilitated discussion on the different approaches to assessing and managing invasive species risk within government. Participants also became more aware of the different perspectives from which this issue is viewed, specifically the science and policy perspectives. Participants expressed an interest in continuing an invasive species risk assessment dialogue among departments and between the risk assessment, climate, and policy communities.

This report summarizes the material presented at the event and synthesizes the discussions and outcomes. The report starts by providing the background leading up to the workshop followed by an overview of climate change in Canada. The next section presents the state of invasive alien species in Canada and the climate change considerations for invasive species in general. This is followed by a closer look at the integration of climate change into invasive species risk assessment and management including when it may be necessary to consider climate change, different approaches, considerations for assessing and managing risk, and the challenges and barriers which may occur when putting such approaches into practice. Concluding remarks follow.

The March 11 workshop was the first event in a proposed series of theme-based workshops to be organized by the PRI. The workshops will focus on the integration or "mainstreaming"[1] of climate change considerations into management practices within the operations of federal government departments; risk assessment and management in departments with regulatory functions represent the first theme to be explored in this context. These workshops are part of a broader research project on climate change adaptation with respect to the federal government's internal operations and are based on the premise that a risk assessment process that incorporates climate change will inform policy makers and allow them to integrate adaptation into departmental planning processes.

2. Background

The impacts associated with a changing climate (e.g., flooding, drought, wildfires) combined with other known stressors (e.g., land use, pollution) challenge the ability of natural systems to adapt. Both terrestrial and marine systems are vulnerable to increased CO_2 and higher temperatures, and are likely to face substantial changes to ecosystem structure and functioning with global warming of two to three degrees above pre-industrial levels.

Ecological threats that are likely to be exacerbated by climate change include invasive alien species (IAS), that is, species that do not naturally occur in a specific area and whose introduction does or is likely to cause economic or environmental harm or harm to human health or well-being. Such species are problematic, because of their ability to succeed in new surroundings, becoming predators, competitors, parasites, hybridizers, and diseases of native and domesticated plants and animals. These traits likely favour invasive alien species in a changing climate.

> *Climate change is likely to increase opportunities for invasive alien species because of their adaptability to disturbance.*[2]

In 2004, the Government of Canada introduced the National Invasive Alien Species Strategy, which outlines approaches and priorities in terms of IAS prevention, early detection, rapid response, and management. The probability of climate change intensifying the threat of IAS is not addressed. As the strategy comes up for review in 2009, the integration of climate change impacts and adaptation could be considered.

In addition to the climate-related risks that may be associated with IAS, some indigenous pests that are native to Canada could pose increasing risk in a changing climate due to a shift in their geographical range. The workshop and this report consider invasive species, both alien and native, as many of the climate-related considerations apply to both, although the risk assessment and risk management approaches may differ.

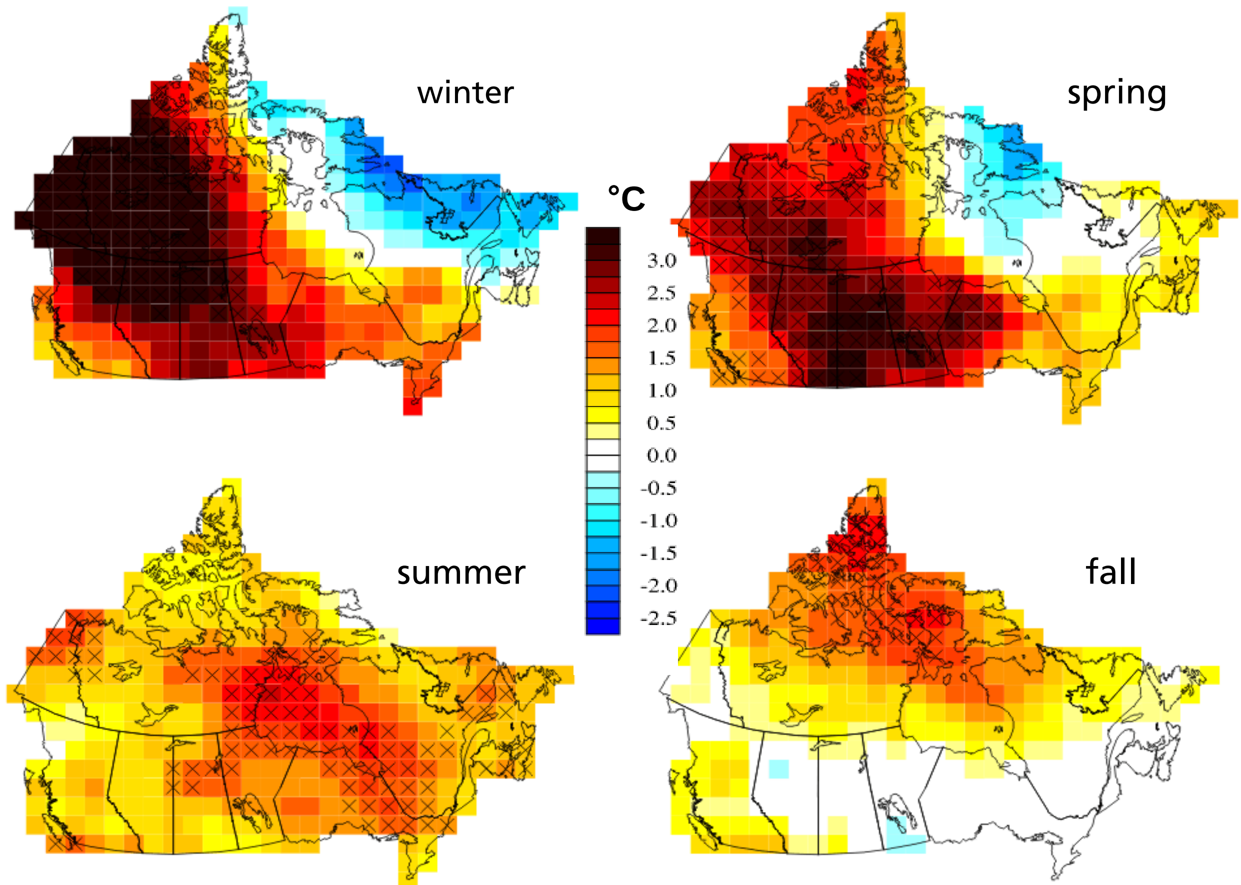
3. Climate Change in Canada – An Overview

To understand the implications of climate change for invasive species, it is important to have a general awareness of how the climate is changing in Canada. In 2008, the Government of Canada released its most recent assessment report "From Impacts to Adaptation: Canada in a Changing Climate 2007," which outlines the current understanding of climate change impacts and adaptation in Canada. The following discussion presents a very general overview of this complicated subject.[3]

Historical Climate Change

There is general consensus that the unequivocal warming of global temperatures over the last century likely results from human activities. From 1906 to 2005, the global temperature increased by 0.74oC. Over this period, the temperature in Canada increased 1.3 oC on average – more than any other country in the world. Regionally, the temperature changes have varied within Canada, with the northwest experiencing the most pronounced increases (Figure 1).

Figure 1 - Temperature Changes in Canada (1950 - 2004): "x" indicates where the trends are statistically significant.



Changes in precipitation have also been observed. In general, wet areas are getting wetter and dry areas are getting drier, and the probabilities of both heavy rainfall and drought have increased. On an annual basis, most of Canada now receives much higher levels of precipitation and experiences an increase in the number of precipitation days. The high north experienced a 45 percent increase in rainfall from 1948-2003 due to warmer temperatures. Conversely, parts of the prairies are getting drier due to less rainfall and increased evapo-transpiration. Snowfall, however, is decreasing, particularly in British Columbia, which has an adverse impact on water availability in the spring.

Another parameter that is changing is sea level. Over the past century, global sea levels increased by a mean of 17 cm leading to increased flooding and coastal erosion. In Canada, Prince Edward Island experienced an approximate rise of 30 cm whereas the west coast experienced a 7 cm rise in sea level.

The changing climate has had several impacts on natural systems; most notably, spring events including leaf unfolding, bird migration and egg laying occur earlier in the year – up to a month earlier in Alberta. Plant and animal ranges are experiencing northern and latitudinal shifts on land. In the oceans, species of fish, algae and plankton are shifting in range and abundance, and fish are migrating into rivers earlier in the year. Other impacts of a changing climate are evident throughout Canada ranging from permafrost degradation and reduced ice cover in the north to reduced lake and river levels in the south.

As the climate continues to change, scientists are attempting to predict what will happen.

Projected Climate Change

Environment Canada uses seven global climate models to inform its projections. Each model is based on a different emission scenario and therefore yields different outputs. Scenarios are based on regionalized measures of population, economic development, energy efficiency, the availability of various forms of energy, agricultural productivity, and local pollution controls.

Based on the global climate projections, temperatures will continue to rise in the future with best estimates suggesting a 1.8 to 4.0 °C increase over the next century with the highest increases occurring under a “business-as-usual” scenario in which no new actions are taken to reduce emissions. Changes in parts of Canada will continue to be more pronounced than the rest of the world continuing trends that have already been observed including relatively sharp temperature increases in the north, particularly in the fall and winter months.

Although temperature projections have a higher confidence than precipitation projections, longer periods without rain are predicted for most of Canada with an increase in higher precipitation events. In the 2050s, an increase in winter and fall precipitation is forecast with regional increases in the north and decreases in the south. Sea levels are also expected to rise with the best estimates projecting a 28 to 43 cm rise by the end of this century.

The resulting impacts will vary regionally across the country but are likely to include severe storms, drought, forest fires, glacier retreat, changes in lake and river levels, permafrost degradation, and fishery impacts.

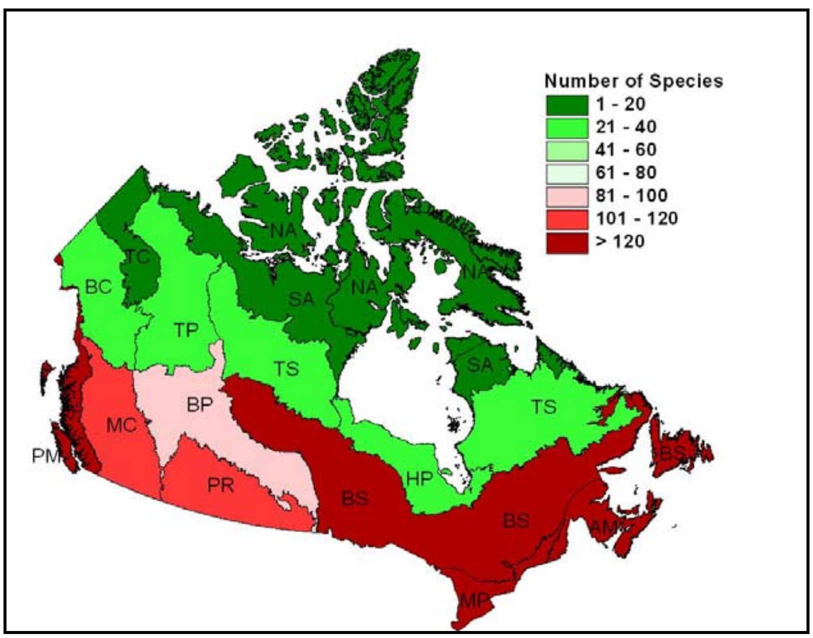
4. Invasive Species and Climate Change

Invasive Alien Species in Canada

Over 1,500 documented IAS currently exist in Canada; most are terrestrial plants. In management terms, plants (terrestrial and aquatic), freshwater fish, micro-organisms, fungi, and invertebrates (terrestrial and aquatic) pose a particular challenge as they are difficult to track and will generally reproduce quickly compared to mammals, birds, amphibians, and reptiles. Invasive alien species have been entering Canada since North America was first settled, with a sharp rise from 1800 to 1900 as a result of increased trade, colonization, immigration, and an increased interest in botany. Heightened awareness and regulatory controls slowed the rate of introductions in the 1900s.

The large majority of IAS within Canada originate from Europe and North Africa followed by Asia. They thrive in landscapes that are similar to their native systems. In addition to the coastal regions and borders where many IAS are first introduced, ecozones, like the boreal forest, host a relatively high concentration of IAS as the habitat is similar to parts of Europe and Asia (Figure 2).

Figure 2 - Numbers of invasive plant species by ecozone, based on the 162 species for which distribution maps are available (Thormann, 2008).



NA – Northern Arctic
TC – Taiga Cordillera
SA – Southern Arctic
BC – Boreal Cordillera
TP – Taiga Plains
TS – Taiga Shield
HP – Hudson Plains
PM – Pacific Maritime
MC – Montana Cordillera
BP – Boreal Plains
PR – Prairies
BS – Boreal Shield
MP – Mixed Wood Plains
AM – Atlantic Maritime

Once established, IAS can have economic, environmental, and social impacts. Managing IAS can be costly in terms of control and eradication attempts, and can lead to indirect economic costs associated with the loss or degradation of ecosystem services and commercially exploited resources. Environmentally, IAS can impact many aspects of ecosystem diversity, structure, and function as they can disrupt the interactions among native species through, for example, out-competing. Depending on the type of species and the location of its outbreak, IAS can have adverse impacts on human health, traditional lifestyles, tourism, employment, aesthetic values, property values, and the general enjoyment of natural areas.

In a warming climate, the adverse economic, environmental, and social impacts associated with invasive species could amplify and spread geographically if the range of the species in question expanded or shifted.

Impacts of the Zebra Mussel [4]

The zebra mussel is an invasive alien species that has been wreaking havoc in the Great Lakes and the St. Lawrence Seaway for 20 years. The ability of the mussel to colonize on a myriad living and non-living surfaces poses many problems. The US Fish and Wildlife Service estimates the potential economic impact to be in the billions of dollars to US and Canadian water users within the Great Lakes region alone due to the buildup of mussels on municipal and industrial water infrastructure. The mussels have also piled up on beaches and colonized on boats and docks affecting recreational activities in the region. Of great concern are the devastating impacts to natural wildlife populations; many native clam species are near extinction, and bird and fish populations have been drastically altered.

Climate Change Considerations for Invasive Species

Over the past 100 years, the temperature and associated climatic conditions (e.g., precipitation) have changed rapidly compared to earlier trends. This rapid change makes it difficult for many species to adapt; those that can adapt quickly under these conditions will be successful. In general, IAS are adaptable to rapid changes and disturbance and are, therefore, able to establish and spread. Consequently, IAS already in Canada are expanding or shifting their range in response to the changing climate, putting new areas of the country at risk.

The same can be said for some indigenous species that have become invasive as the changes in climate have made new areas physically suitable for their expansion. A noted example is the mountain pine beetle that is native to British Columbia. This forest pest has expanded beyond its typical range in recent years devastating acres of forest in British Columbia and Alberta, aided by warmer conditions that have allowed the beetles to survive through the winter. Another example is the gypsy moth, an alien invasive species from Eurasia that is predicted to spread further into Canada as the climate changes.

When considering the implications of climate change for invasive species, it is important to distinguish between climate and weather. The weather refers to short-term changes in temperature and precipitation and can change dramatically from hour to hour, day to day, and season to season. The climate for a given area will dictate the range of weather possibilities and as the climate changes over the long term (i.e., decade to decade), the range of weather possibilities will gradually shift as well.

Gypsy Moth and Climate Change

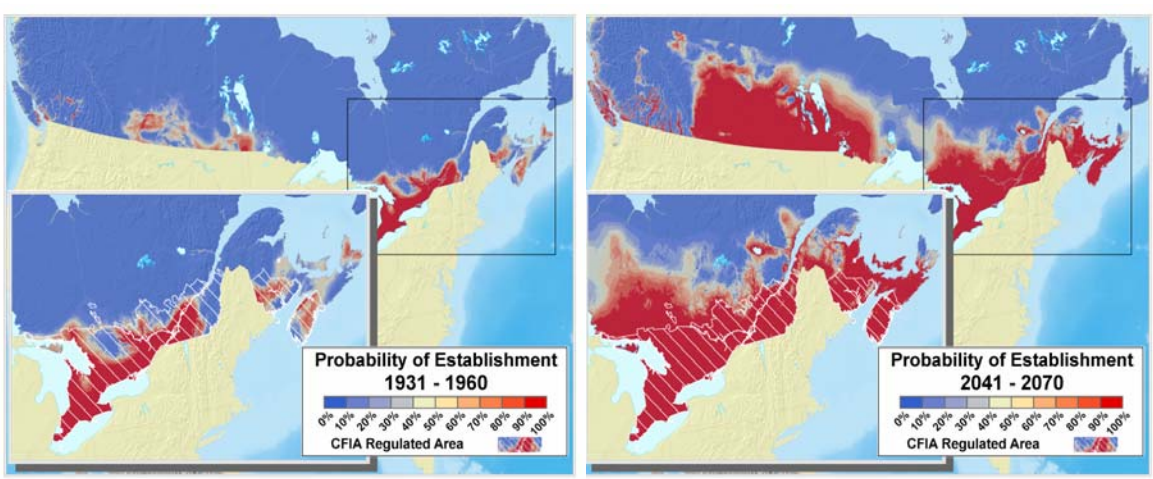
The gypsy moth is a defoliator from Eurasia first reported in Canada in the 1930s, but it did not become firmly established until the 1960s. Today, the gypsy moth is established in southern Ontario, southern Quebec, southwestern New Brunswick, and southwestern Nova Scotia. There are over 300 known host plants for the gypsy moth. In North America, the long list of preferred hosts includes oak, cherry, white birch, maple, alder, willow, elm, and trembling aspen. The Asian race, which is currently threatening British Columbia, also does well on coniferous trees, such as larch.

The Canadian Forest Service uses an eco-physiological approach to predict the movement of the gypsy moth in a changing climate. Using predicted changes in climate, a detailed knowledge of the gypsy moth ecology, its basic thermal responses, and the host range, the BIOSIM model used by the Canadian Forest Service generates maps that indicate the probability of establishment based on whether the pest will be able to complete its life cycle.

The two maps below illustrate results for two time periods. The first map shows the probability of establishment during the period in which the moth was first introduced (1931-1960) and the second map shows the probability of establishment for the years 2041-2070. These results clearly indicate how a changing climate could facilitate the expansion of the gypsy moth further into Ontario and Quebec, well beyond the existing regulated areas, and render the prairies more vulnerable to gypsy moth invasions. It should be noted that these results are based on a conservative emission scenario of a one percent increase in CO_2 each year from 1990 to 2100.

This model is a very powerful and informative tool. This insight into the future will allow scientists, policy analysts, and decision makers to develop and evaluate risk management options for these vulnerable areas before they become affected.

Figure 3 - Probability of Establishment for Gypsy Moth - Maps from the Canadian Forest Service BIOSIM model (*Presented by Jacques Régnière, March 11, 2008*).



Sources: CFIA (2007) and CFS (2007).

All ecological interactions are influenced by climate, and the organisms that live in a given climate do so because of their favourable probability to succeed and complete their life cycle. That being said, many organisms can be highly sensitive to fluctuations in weather and weather extremes. Many insects, for example, can be killed by one cold episode in the winter, which prevents outbreaks in the spring. In this example, weather extremes influence the population of the insect (either native or alien). The climate, however, will influence the frequency or probability of such extreme events happening. If mean temperatures increase gradually over the long term, then the probability of temperatures getting cold enough for a winter kill could decrease over time.

5. Climate Change and Invasive Species Risk Assessment/Risk Management

When to Consider Climate Change

It may not always be appropriate or necessary to consider climate change when conducting an invasive species risk assessment. Whether to consider climate change largely depends on the status of the species in question and whether they will be present over the long term.

There are three invasive species categories under which different approaches may be required.

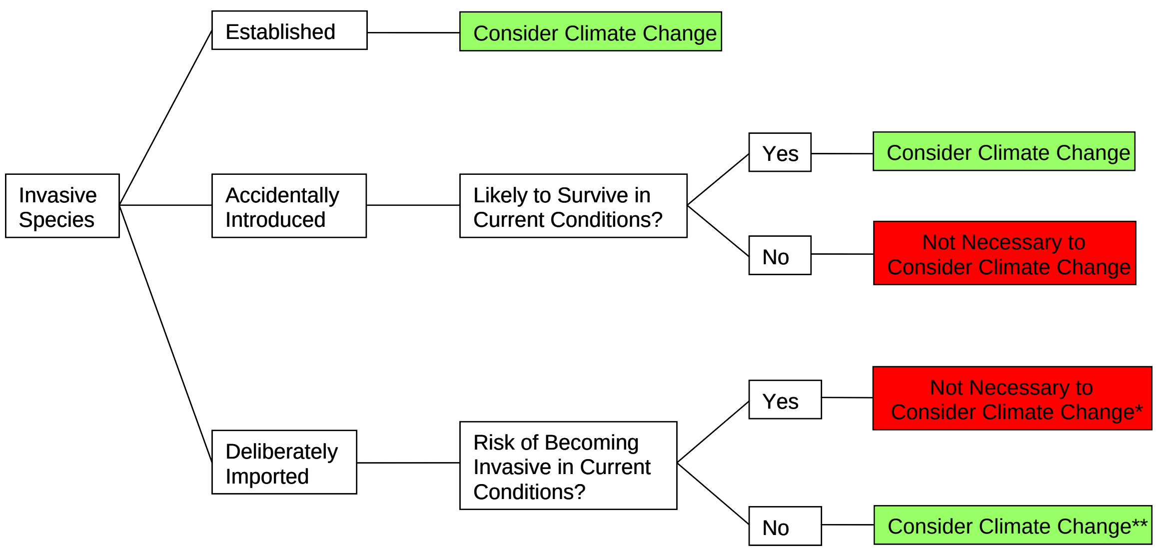
- **Species that are already established (native or alien) in North America:** To assess the risks associated with an established pest, it will be important to think long term to determine if and how the range of this pest will shift or expand over several decades based on the current understanding of climate change in the region. Although confidence in the projections will vary, a general sense of risk over the long term will give policy and decision makers at all levels an opportunity to explore risk control options. Risk management is discussed later in this report.

- **Alien species that have been (or could be) accidentally introduced:** If a species is accidentally introduced, the current climate and its respective weather fluctuations will determine whether the species will survive in the short term. If the habitat in which this species is introduced is unlike its native habitat, then it is unlikely to survive the day-to-day and seasonal fluctuations in weather. If this is the case, then there is no need to consider long-term changes in climate. Should the probability of establishment be significant, climate change could be considered to forecast the potential impacts over the long term should initial control and mitigation efforts fail. With respect to those species that are at risk of being unintentionally introduced (e.g., insects in wood packaging), the same criteria would apply. However, the spatial scope of a risk assessment would consist of locations in which a potential introduction could occur; these could consist of ports, borders, or other anticipated hot spots. (See a discussion on identifying hot spots below.)

- **Deliberately introduced alien species:** When Canadians decide whether to import a non-native species for agricultural production or commercial use, many factors are considered, including the probability of the species becoming invasive. If there is a chance that the species could become invasive under current climate conditions, then it is unlikely to be imported, in which case it is not necessary to consider long-term changes in climate. If the risk of the species becoming invasive under current climate conditions is low, then it may be necessary to consider whether the risk of invasion will increase in a changing climate before a decision is made to import the species. The decision to introduce a species is permanent and thus it is important to take into account the long-term changes that could affect the species (and the host, if applicable) to assess if the risks could increase over time.

Figure 3 provides a rough guide for when to consider climate change in an invasive species risk assessment. As a simple rule, climate change should be considered if the species will be, or could be present (i.e., in the case of a deliberate or accidental introduction) in the long term. In reality, there will be uncertainties associated with questions concerning likelihood of survival and the risk of becoming invasive; however, decisions will be guided by probabilities as with any risk assessment/management process.

Figure 4 - Guide to the consideration of climate change in invasive species risk assessment work – inspired by workshop outcomes



* Assuming an IAS *is not* imported
** Assuming an IAS *is* imported

Approaches and Considerations

Climate change is not formally incorporated into most invasive species risk assessment processes within the federal government. Although it could be considered another variable in the process, the long-term nature of climate considerations adds a temporal component that is not typically addressed.

When it is appropriate to consider climate change, a logical way to integrate it into invasive species risk assessment is to identify and evaluate risk using existing approaches (i.e., current climate conditions and weather fluctuations) to create a baseline. These initial steps can then be repeated using projection data for a given time in the future.

Conducting the risk assessment using two sets of climate data (current and projected) can provide risk assessors and decision makers with a sense of how the risks associated with a given invasive species could change over time and perhaps geographically. This information could be very relevant in informing decisions (i.e., whether to allow the species into Canada) and crafting management options (both mitigation and adaptation).

Obtaining the necessary climate information to incorporate into a risk assessment could be challenging. When considering climate models for invasive species applications, it is important to use the finest scale possible to focus on the geographical area of concern. There are different ways to approach this. The first way is to use regional climate models. In theory, it would be best to use models that are region-specific; however, regional climate data are difficult to obtain, and the confidence in the projections is going to be lower as there will not be multiple models from which to obtain results. With the exception of some regions for which reliable models have been developed, statistical downscaling of global circulation models is likely the best approach and perhaps the only option.[5] In terms of selecting a time frame for climate projections, there is no single answer, but a projection of at least 20 years is needed to make a useful comparison.

Once climate change projections have been identified, models can then be used to predict how organisms will behave given the changes in temperature and precipitation using correlative approaches or the eco-physiological approach. The Canadian Forest Service uses the eco-physiological approach to model the spread of forest pests. This shows the probability of the organism completing its life cycle within the climactic boundaries given the range of the host species. This approach requires knowledge of the basic thermal responses (e.g., overwintering mortality) of a particular species and knowledge of its ecology including natural enemies and competitors.

The eco-physiological approach can be tailored to a specific species creating a very powerful tool for predicting the movement of an existing or potential pest over time. This is an ideal tool for known pests (e.g., mountain pine beetle and gypsy moth), but will have limitations when applied to new and relatively unknown species as there is unlikely to be sufficient knowledge of the key ecological parameters.

When considering which regions in Canada could be most at risk for invasive species introductions and outbreaks, in general or for a specific species, regional climate projections can be merged with various geographic information system (GIS) layers to determine potential hot spots for a given period. This could be an effective way to incorporate the socio-economic drivers with the physical conditions of the environment that may support the spread of a given species. Transportation corridors, ports of entry, urban development, agricultural expansion, natural resource development, and areas of enhanced – and growing – recreation and tourism are all examples of GIS layers that could influence the probability of invasive species introductions (in the case of IAS) and movement. By merging this information with current knowledge of the natural environment (including climate), we can identity hot spots or suitable habitats for invasive species and the potential environmental, economic, and social impacts. Merging opportunities may also exist for regional planning and other landscape management models. Once such hot spots are identified, an appropriate policy response may be to develop monitoring programs for those areas most likely to be affected by invasive species under a changing climate.

Managing Risk

Following an invasive species risk assessment, options are formulated to reduce risk and control any adverse impacts that could occur. In the event of an IAS or native pest outbreak, or threat of an outbreak, a series of control or eradication options are often evaluated. These mitigation efforts are typically implemented at the problem site and are intended to address immediate or short-term concerns. Once a species is established, a different set of management options are needed and could consist of both mitigation and adaptation responses.

In the context of a changing climate, adaptation is seen as a necessary complement to mitigation. The Intergovernmental Panel on Climate Change (IPCC) defines adaptation as the "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities."[6] Adaptation, as a risk management approach, may become increasingly important in responding to invasive species. As the range of an invasive species and its associated impacts expands or shifts in response to climate change, planned adaptation strategies could be considered for those areas currently affected or likely to be affected to minimize the adverse effects and perhaps even exploit benefits and opportunities over the long term.

Adaptation strategies for invasive species could take many forms depending on the type of species and the natural and socio-economic characteristics of its current and predicted range. Possible examples include the altering of forest management practices in threatened areas to reduce vulnerability to forest pests and redesigning public parks and green spaces to reduce exposure to disease vectors (e.g., mosquitoes).

Any decision involving uncertainty and long-term considerations necessitates a re-examination of supporting science and the evidence as it becomes available to ensure that existing management frameworks continue to be appropriate. It is also important to build flexibility into policies and programs to allow for minor, or even fundamental, changes to our management approaches. Adaptive management is an iterative process of decision making that is suitable for issues such as climate change and its effects, including invasive species.

We will never have certainty with respect to climate change, but there is enough confidence in the general trends to foster the development of adaptive management strategies. Continuous improvements to our understanding of climate change and our models can provide new insight. Adaptive management will allow for new knowledge to be integrated into related policies and programs including mitigation and adaptation strategies.

Monitoring is a key component of many adaptive management approaches. The monitoring of existing invasive species populations and potential entryways is occurring in Canada. Monitoring of potential IAS hot spots may also be appropriate; potential hot spots can be inferred from the merging of GIS layers and climate data. To ensure that adaptive management is supported, monitoring results will need to be formally integrated into the policy process to determine when and if revisions are required.

Challenges and Barriers

Integrating climate change into federal risk assessment and management frameworks may face challenges. As with many of the factors considered in a risk assessment, climate change has a significant element of uncertainty. This can be challenging to address and is particularly true when conducting an analysis that is region and species specific. Although models are always being modified and updated, it is difficult to know if the accuracy of climate change projections is going to improve. Nevertheless, the climate is changing and is likely to have continuous implications for invasive species. It will therefore be important to consider the changing climatic conditions to the best of our abilities when assessing long-term risks. As previously discussed, management strategies consistent with an adaptive management approach will allow for new insights to be incorporated iteratively and policies and practices to be revised as necessary.

With many scientific and technical exercises, data availability is likely to be a challenge. It has already been noted that climate data are more readily available at the global scale than at the regional scale. Further, taking an eco-physiological approach to projecting climate-related impacts on the spread of a given species requires biological knowledge of the species and its thermal responses as well as the host species, which may limit the use of this tool to well-known organisms until more data become available.

Climate-related and biological uncertainties relating to climactic and ecological interactions of a species can inform the prioritization of research needs; research could focus on those parameters and issues for which we have little data, confidence, and understanding.

From an organizational perspective, issues concerning capacity could also pose many challenges. Conducting the proper analysis related to climate change requires additional time and strains existing resources. Further, there is the issue of expertise and access to climate data. Some federal departments have internal climate change expertise; others do not. To ensure that climate change is properly integrated into the risk assessment process (e.g., modelling, analysis, etc.) expertise may need to be acquired either directly or by making arrangements with other federal departments or agencies.

More generally, the issue of climate change awareness and uptake may pose a barrier to mainstreaming efforts. Before climate change is broadly considered in our day-to-day business, there needs to be a basic understanding of the subject and an appreciation for how it affects the mandates of our respective organizations. In many cases, this could require awareness building and education.

It may be necessary to incorporate climate change formally into risk assessment and management, and other decision-making processes to ensure that it is considered. This could be particularly true for those working in policy analysis and development where there may be a disconnect from the science and supporting information.

Assessing and evaluating invasive species risk over the long term will likely require additional technical inputs and confront several institutional barriers. These needs and challenges are summarized below.

Scientific Needs and Considerations

- Global or regional climate model
- Climate data availability and quality (for regional models)
- Statistical downscaling (for global models)
- Detailed knowledge of organism (for eco-physiological models)
- Uncertainty
- Monitoring

Institutional Challenges

- Climate change awareness
- Expertise (climate and technical)
- Access to data
- Risk assessment time and staff
- Consideration by policy staff/experts
- Lack of long-term decision-making processes and approaches

6. Conclusions and Next Steps

Climate change has yet to be incorporated into most invasive species risk assessment and risk management work conducted within the federal government. A recent report from the Environmental Law Institute notes that the United States is in a similar position (EPA, 2008). The range of established species may expand or shift as the climate changes, which could increase the risks in currently affected areas and render new areas vulnerable to adverse economic, social, and environmental impacts. It is important to examine these factors when conducting risk assessments to ensure that the proper mitigation and adaptation options can be evaluated. It will also be important to assess long-term risk when contemplating the intentional introduction of an alien species to determine if the changing climate could support invasive traits in a species that poses little threat under current conditions.

In terms of approach, the integration of climate change into a given risk assessment would require the identification and evaluation of risks using at least two sets of climate data – current and projected (>20 years). This will provide insight into possible changes over time both in terms of geography and magnitude, which can be very informative in developing short- and long-term policy responses and adaptive management strategies.

From a technical perspective, some issues will need to be resolved in terms of selecting the appropriate tools and models for obtaining information on projected climate conditions and the associated interactions with the organism in question (or its hosts or vectors). As with many of the parameters considered in a risk assessment, issues with respect to uncertainty and data availability associated with the climate change inputs will need to be addressed.

Institutional challenges will also need to be addressed to ensure that climate change is considered in assessing and managing invasive species risk. Many of these challenges are related to capacity and awareness within federal organizations. It would appear that departments may need to examine issues of expertise, time demands, and general understanding of climate change and its implications for the mainstreaming of climate change considerations into risk assessment processes to take place.

Notes

[1] In the context of adaptation, mainstreaming refers to the integration of adaptation considerations (or climate risks) into policies, programs, and operations at all levels of decision making. The goal is to make the adaptation process a component of existing decision making and planning frameworks (Bo, 2005).

[2] Stachowicz et al. (2002); Lake and Leishman (2004), from IPCC WGII.

[3] The report can be consulted for further information (NRCan, 2008).

[4] Information from USGS (2008) and GLU (2008).

[5] Downscaling is a method for obtaining high-resolution climate or climate change information from relatively coarse-resolution global climate models (GCMs). Typically, GCMs have a resolution of 150-300 km by 150-300 km. Many impact models require information at scales of 50 km or less, so statistical downscaling methods are needed to estimate the smaller-scale information (UNFCCC, 2004).

[6] IPCC (2007: Appendix 1: Glossary).

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Note: All URLs were confirmed as of August 2008.

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Appendix 1 – Workshop Agenda

INTEGRATING CLIMATE CHANGE INTO INVASIVE SPECIES RISK ASSESSMENT/RISK MANAGEMENT

A Workshop Sponsored by the Policy Research Initiative
and the Canadian Food Inspection Agency

Tuesday, March 11, 2008
Government Conference Centre – 2 Rideau Street – Colonel By Room

Objectives

To create awareness of the impact of climate change on invasive species and how climate change considerations can be integrated into invasive species Risk Assessment (RA) / Risk Management (RM) work within the federal government by:

- Increasing our awareness of climate change impacts and adaptation.
- Identifying key climate change considerations with respect to invasive species.
- Exploring how these considerations could be integrated into current RA/RM approaches.

Road Map

08:00 Coffee

A. GETTING STARTED/CONTEXT

08:30	Welcome/Purpose	***Bernard Cantin (PRI)*** ***Ian Campbell (CFIA)***
	Process Review • How we will work together • Introductions	***Facilitator***
09:00	Background on Climate Change Impacts & Adaptation	***Jacinthe Lacroix (Environment Canada)***
	Climate Change Considerations for Invasive Species	***Markus Thormann (University of Alberta)***
09:30	Open Forum – Q&A • Questions of clarification	
09:45	Discussion 1. What were the key messages? 2. What are the key climate change considerations?	

10:15	Health Break	

B. CLIMATE CHANGE AND RA/RM

10:30	Lessons Learned: Mountain Pine Beetle	***Jacques Régnière – Canadian Forest Service***
	Open Forum – Q&A • Questions of clarification	
11:15	Discussion 1. How did CFS integrate climate change into its RA/RM approach? 2. To what degree do your current RA/RM approaches consider climate change?	
12:00	Lunch (provided)	

C. INTEGRATING CLIMATE CHANGE INTO RA/RM

13:00	Case Study – West Nile Virus	***Anne Morin (PRI)***
13:30	Group Exercise • Based on a RA/RM approach that includes o Step 1 - Risk identification o Step 2 - Risk evaluation 1. How are climate considerations incorporated into the risk assessment? 2. What will we need to incorporate climate change considerations?	
14:30	Health Break	
14:45	Group Exercise Continued o Step 3 - Risk Control	
15:15	Discussion of Case Study	***Facilitator***
16:00	Next Steps • Where to from here?	***Bernard Cantin (PRI)***
	Wrap Up / Evaluation / Closure	
16:30	Adjourn	

Appendix 2 – Participant List

NAME / NOM	JOB TITLE / TITRE	ORGANIZATION / ORGANISME
Josée Arbique	Gestionnaire	Fisheries and Oceans Canada
Edward Black	Senior Advisor, Aquaculture	Fisheries and Oceans Canada
Ian Campbell	Director	Canadian Food Inspection Agency
Bernard Cantin	Senior Policy Research Officer	Projet de recherche sur les politiques
Lesley Cree	A/National Manager	Canadian Food Inspection Agency
Heather Danielson	Science Advisor	Canadian Food Inspection Agency
Kirsten Finstad	Senior Science Advisor	Canadian Food Inspection Agency
Harvey Hill	Manager	Agriculture and Agri-Food Canada
Jacinthe Lacroix	Conseiller scientifique principal, Changements climatiques	Environnement Canada
Paul Lyon	Policy Analyst	Fisheries and Oceans Canada
Anne Morin	Policy Research Officer	Policy Research Initiative
Holly Palen	Policy Analyst	Canadian Forest Service
Jacques Régnière	Chercheur scientifique	Centre de foresterie des Laurentides
Peter Reinecke	Policy Research Officer	Policy Research Initiative
Don Rivard	Senior Advisor Environmental Quality	Parks Canada
Andrea Sissons	Plant Health Risk Assessor	Canadian Food Inspection Agency
Marcus Thormann	Professor	University of Alberta
Sima Vyas	Animal Health Science Advice Officer	Canadian Food Inspection Agency
David Welch	Head, Environmental Quality	Parks Canada
Brent Larson	Standards Officer	International Plant Protection Convention
Warren Wilson	Facilitator	The Intersol Group Inc.