6 RECOMMENDATIONS

6.1. Risk Analysis for Climate Change and Biodiversity at the Community Level for Planning/Policy Development

The Hazard Identification and Risk Assessment (HIRA) process is recommended to help communities identify and assess their risk from a variety of potential threats to biodiversity that may lead to significant ecosystem dysfunction.

Risk analysis identifies the critical level of disturbance caused by climate change at which a native ecosystem becomes vulnerable. Potential threats include tornadoes and hail (both of which cause mortality and damage to trees, plants, animals, livestock, pets and crops), wildfire, lightning, floods (Class 1+), heavy snow, hurricanes (Category 3+), windstorms, extreme heat/cold, ice storms, drought (a month or longer in duration) and other climate extremes.

Not only are extreme events a critical factor in climate change, but they also have a greater correlation to predicted changes in biodiversity than climate change alone. Although ecosystems show high resilience to hurricanes, ice storms and other extreme events, significant impacts on biodiversity may occur once certain thresholds in duration, intensity and severity are exceeded. The resulting losses in biodiversity can reduce ecological resilience and adaptive capacity to climate change.

The risk analysis may also include:

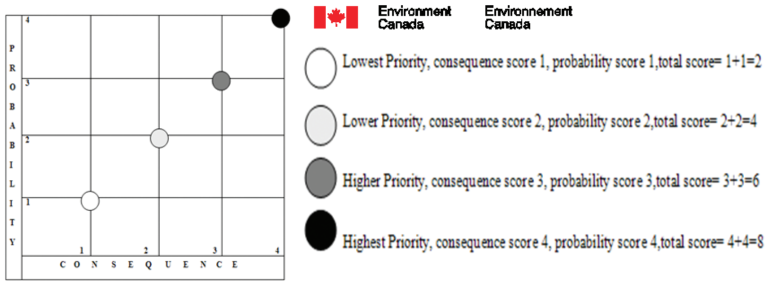
- identifying ecosystems most threatened by pests;
- determining interactions between invasive species and native species;

- determining which species have the potential to increase their range under climate change and the ecological consequences of this increase;
- determining which native species have the potential to become invasive; and
- identifying species and areas most vulnerable to the combination of climate change and other stresses, such as invasive species, habitat loss and fragmentation.

Figure 71 shows a sample risk assessment grid in which the y-axis indicates the frequency or probability of a climate extreme or risk to biodiversity while the x-axis indicates the impact or consequence to biodiversity from the incidence of the climate extreme (adapted from Emergency Management Ontario, 2004).

The climate extremes and their impacts are ranked and scored according to their frequency of occurrence, their impacts or consequences and, in some cases, by the community's capacity to respond to a climate extreme. With simplicity in mind, the frequency or probability of climate extremes is ranked from 1 to 4, with 1 reflecting a low occurrence rate and 4 reflecting a high occurrence rate within the past 15 years.

The impacts or consequences from a climate extreme are also ranked from 1 (negligible) to 4 (high). The degree of consequence has been determined through consultation with experts. A "high" impact score reflects a likelihood of severe loss of biodiversity and ecosystem functioning. Events that have a low probability but are high impact, such as severe ice storms in a community where adaptive capacity is limited, are often ranked as a higher priority risk, requiring priority disaster response planning and risk reduction initiatives.



Probability of Occurrence	*Consequence*
1- No history in last 10-15 years	*1- Negligible*
2- Greater than 5 years	*2- Limited*
3- One incident in the last 5 years	*3- Substantial*
4- Greater than one incident in the last 5 Years	*4- High*

Source: EMO, 2003

Figure 71. Risk assessment grid showing risk to biodiversity from climate extremes based on threats to biodiversity (y-axis) and consequences to biodiversity (x-axis)

6.1.1. National and International Examples of the HIRA Process

Preliminary examples of how the HIRA process can be applied and its potential to compare and assess threats to biodiversity are shown below.

6.1.1.1. Mountain Pine Beetle Epidemic

The mountain pine beetle (*Dendroctonus ponderosae*) epidemic in British Columbia is an example of an event that is high probability and has a high impact on biodiversity (Figure 72).

6.1.1.2. Threats in the Urban Forest

Human impacts in sites such as the Toronto Zoo, as well as land conversion, fragmentation or forest management practices such as prescribed burns, are high probability and have a high impact on biodiversity (Figure 73).

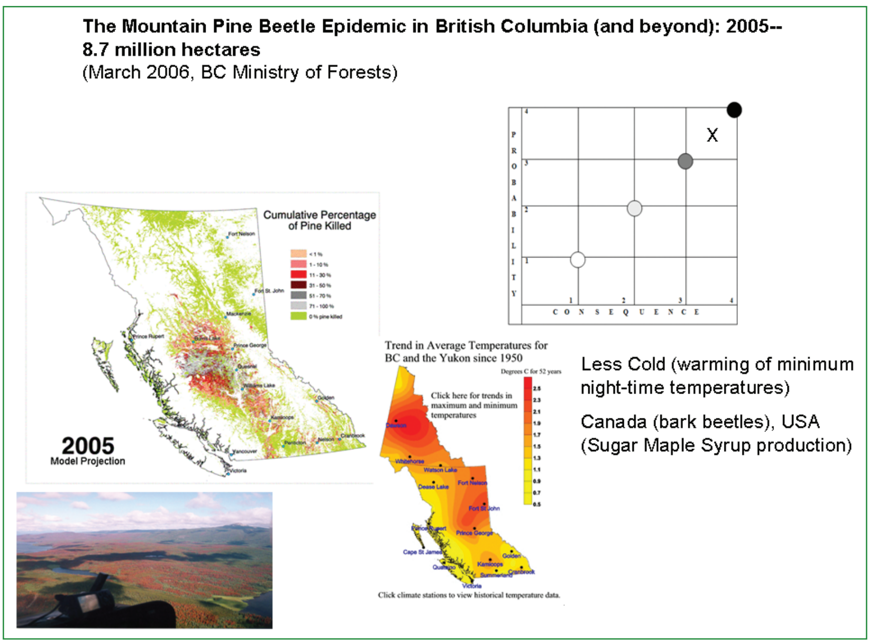


Figure 72. Assessment of an insect epidemic using the risk assessment grid

6.1.1.3. Ice Storms

Severe ice storms in eastern Ontario and Quebec are low probability but have a high impact on biodiversity. Preliminary analysis suggests that trees may not recover if crown damage is >75%. A hypothetical example in which damage is this extensive is plotted on the risk assessment grid (Figure 74).

6.1.1.4. Hurricanes

Category 3+ hurricanes in Puerto Rico are high probability and have a high impact on biodiversity (Figure 75). Similar assessments could be applied to tornadoes in Ontario.

6.1.1.5. Multiple Impacts

Communities often experience multiple and complex risks to their biodiversity. The top 10-15 risks in the Caribbean may be identified and analyzed using the HIRA methodology (Figure 76): hurricanes, deforestation and agriculture (high probability, substantial consequence to biodiversity); floods, droughts, earthquakes and volcanoes (substantial probability, substantial consequence to biodiversity); and ranching, fires, urbanization and introduced species (limited probability, limited consequence to biodiversity).

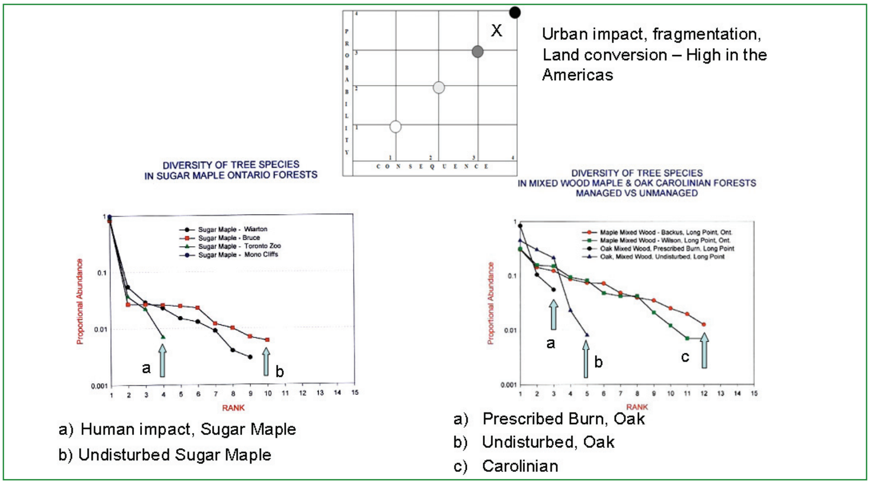
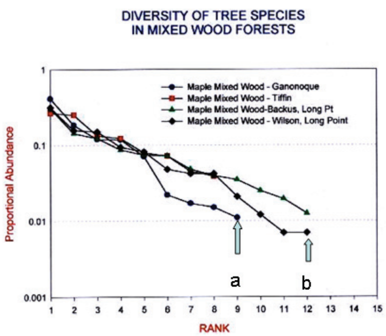
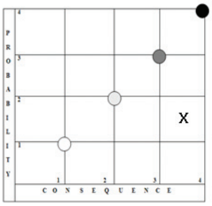


Figure 73. Assessment of threats in the urban forest using the risk assessment grid



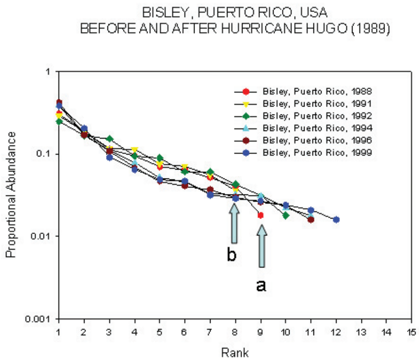


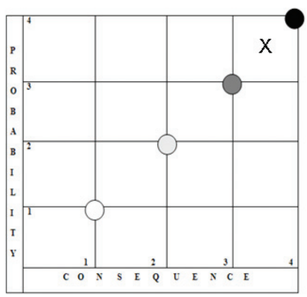
Severe Ice-storm (> 75% crown damage) – low probability, high consequence

a) Sugar Maple at Gananoque - site of ice-storm (< 75% crown damage)

b) Carolinian at Long Point, Ontario

Figure 74. Assessment of ice-storm damage using the risk assessment grid (>75% crown damage)





Hurricanes (Cat 3+)

a) Prior to Hurricane Hugo, Puerto Rico

b) One-year after Hurricane Hugo

Figure 75. Assessment of hurricane damage using the risk assessment grid

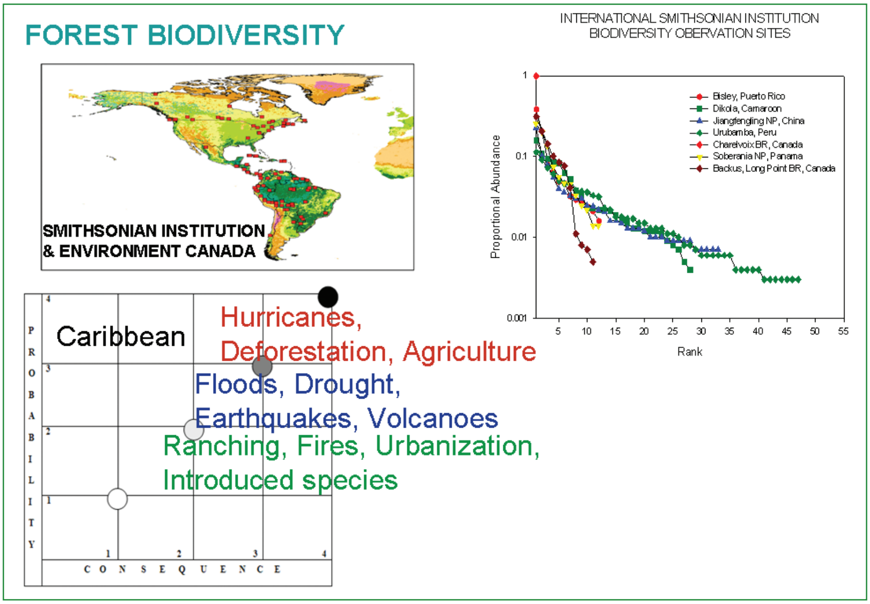


Figure 76. Assessment of multiple impacts using the risk assessment grid

LIST OF ACRONYMS

ACER	Association for Canadian Educational Resources
ASD	Automated Statistical Downscaling
CARE	Centre for Atmospheric Research Experiments
CBD	Convention on Biological Diversity
CCCSN	Canadian Climate Change Scenarios Network
CRCM	Canadian Regional Climate Model
DBH	Diameter at Breast Height
GCM	Global Climate Model
GDD	Growing Degree Days
GHG	Greenhouse Gas
GIS	Geographic Information System
GLP	Growth Layer Profile
HIRA	Hazard Identification and Risk Assessment
IMAP	Integrated Mapping Assessment Project
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
MEA	Millennium Ecosystem Assessment
NBOS	Network of Biodiversity Observing Sites in Canada
ONE	Ontario's Niagara Escarpment Monitoring Program
SDSM	Statistical DownScaling Model
SI/MAB	Smithsonian Institution Monitoring and Assessment for Biodiversity
TRIM	Tree Ring Increment Measuring System
UNCCD	United Nations Convention to Combat Desertification
UNFCCC	United Nations Framework Convention on Climate Change
WBO	World Biodiversity Organization
WMO	World Meteorological Organization

LIST OF TREE SPECIES

Balsam fir	*Abies balsamea*
Balsam poplar	*Populus balsamifera*
Beech species	*Fagus sp.*
Black spruce	*Picea mariana*
Douglas fir	*Pseudotsuga menziesii*
Eastern flowering dogwood	*Cornus florida*
Eastern hemlock	*Tsuga canadensis*
Garry oak	*Quercus garryana*
Jack pine	*Pinus banksiana*
Lodgepole pine	*Pinus contorta*
Red maple	*Acer rubrum*
Red oak	*Quercus rubra*
Red pine	*Pinus resinosa*
Sugar maple	*Acer saccharum*
Trembling aspen	*Populus tremuloides*
White pine	*Pinus strobus*
White spruce	*Picea glauca*
Willow species	*Salix sp.*

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