

***Nova Scotia Endangered  
Species Act***  
Action Plan Series

Action Plan for the Recovery of Eastern  
Moose (*Alces alces americana*) in  
Mainland Nova Scotia



**2014-2018**

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## **ADDITIONAL COPIES:**

Additional copies can be downloaded from the Nova Scotia Department of Natural Resources Species Recovery and Conservation webpage.

([http://www.gov.ns.ca/natr/wildlife/biodiv/species\\_recovery.htm#moose](http://www.gov.ns.ca/natr/wildlife/biodiv/species_recovery.htm#moose))

## **COVER ILLUSTRATION:**

Photographed by Danielle Pernette, Mersey Tobeatic Research Institute.

## **RESPONSIBLE JURISDICTIONS:**

Government of Nova Scotia:  
Nova Scotia Department of Natural Resources

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## **DISCLAIMER:**

This recovery action plan does not necessarily represent the views of all of the individuals involved in its formulation, nor of the governments or organizations with which the individual team members are associated. The goal, objectives, strategies, and actions are based on the best existing knowledge and are subject to modification resulting from changed objectives and new findings. The implementation of the actions identified in the plan will be subject to priorities and budgets of participating jurisdictions and organizations. Therefore, some aspects of this recovery plan may not necessarily be implemented immediately, concurrently, or in their entirety.

## EXECUTIVE SUMMARY

Nova Scotia's mainland moose (*Alces alces americana*) were listed as Endangered under Nova Scotia's Endangered Species Act (S.N.S. 1998, c.11) in 2003 due to the small, declining population and poorly understood, complex threats faced by the species. The stated goal of the Recovery Plan, developed in 2007, is to "maintain the population of mainland moose in Nova Scotia within their current range" and the identified recovery objectives are to: 1) maintain and enhance the current population and distribution; 2) mitigate threats that limit recovery; 3) initiate research to address priority knowledge gaps; and 4) maintain and enhance habitat. The Recovery Plan identifies known threats and knowledge gaps and specifies a number of actions required to meet the recovery objectives (NS DNR 2007).

This document contains the Action Plan for the recovery of moose in mainland Nova Scotia and is intended to complement the Recovery Plan by reporting on progress achieved to date on the actions identified in the Recovery Plan and by identifying the specific tasks and actions required to move forward and achieve the recovery objectives.

Progress has been made on some of the actions identified in the Recovery Plan, including: increased understanding of the distribution of moose, examination of the response of radio collared moose to thermal cover, improved understanding of the relationship between moose occurrence and forest stand structure, development of Special Management Practices for forestry activities on provincial crown lands, education efforts to reduce poaching and increase public sighting reports, post-mortem examination of all moose found dead and construction of ramps to reduce mortality in bogs (See **Table 1** for details on these and additional action items). Despite the progress, much remains to be done to recover mainland moose and many knowledge gaps remain.

This Action Plan identifies 5 inter-related tasks to fill these knowledge gaps and begin to work towards recovery. Each is outlined in **Section 4** along with its associated rationale, sub-tasks, actions and deliverables. The Mainland Moose Recovery Team has identified a number of actions that are the highest priority to complete within the next five years. These highest priority items and their associated costs are identified in the action table listed under each task.

**Task 1- Provide reliable data on the distribution, abundance and population structure of mainland moose in Nova Scotia:** Accurate and timely information on the distribution and abundance of moose in mainland Nova Scotia is essential to understanding the threats affecting moose, designing management programs and evaluating successes. This high priority task involves several research projects to develop a reliable long term monitoring program for mainland moose in Nova Scotia. Identified subtasks include evaluating a number of techniques to monitor moose populations in Nova Scotia; estimating abundance and developing a monitoring strategy and examining population genetic structure.

**Task 2- Develop tools to support decisions in forest management planning at multiple spatial scales for moose habitat requirements:** Moose decline on mainland Nova Scotia has originated and persisted through a complex, and inadequately understood, range of interrelated factors. A key, but poorly

understood, factor is the influence of available habitat. This task involves describing moose spatial and temporal habitat requirements from GPS radio collar telemetry and existing datasets, and developing a landscape-level habitat suitability model to provide the tools that can guide management practices.

**Task 3- Undertake studies on threats and limiting factors to enable an understanding of the causes of moose population decline:** Mainland moose face many potential threats and limiting factors including disease; habitat loss, fragmentation and alteration from development and forestry practices; poaching; vehicular collisions; climate change; and deficiencies in trace elements and/or elevated levels of toxic heavy metal uptake resulting from acidification. The severity of each, the interactions among them, and the variation across geographic regions remain largely unknown. This task involves two primary components to begin to address these complex questions: 1) conducting a series of research projects designed to examine specific threats; and 2) modelling the relationships among threats.

**Task 4- Provide and implement management strategies leading to the recovery of the moose population:** While the many threats facing moose are complex and poorly understood, there are some measures that can be undertaken concurrently with the studies identified in tasks 2 and 3 to begin to reduce specific threats. This task involves three management initiatives: 1) decrease known causes of mortality such as poaching and vehicle collisions; 2) reduce threats to habitat and promote landscape connectivity by working with government, industry, landowners and other partners; and 3) examine the potential for increasing recruitment.

**Task 5- Raise public awareness, build partnerships and encourage stewardship of mainland moose in NS:** Successful recovery of species at risk typically requires the commitment of many partners and groups including government agencies, industry, Aboriginal organizations, private landowners and local organizations. This is particularly important for a species such as moose that occurs over a wide landscape and requires a variety of habitats. While recovery efforts to date have included some engagement and public awareness initiatives, primarily undertaken by NS DNR staff, much remains to be done. This task includes the development of a strategic communications plan as well as actions to engage partners in the stewardship of mainland moose and to raise public awareness of moose and the threats they face.

The recovery measures outlined in this document are expected to positively impact ecological integrity in the region by encouraging stewardship and sustainable management. Mainland moose are a unique and valuable resource in Nova Scotia and if recovery is ultimately achieved to levels that permit hunting, moose will contribute to local ecotourism, generate revenue from hunting licences, and once again become a food source for Aboriginal groups. Achieving this recovery is particularly dependent on a strong commitment from the government of Nova Scotia, and the engagement of industry, private landowners and many partners. In the face of continued decline and increasing pressure on woodland habitats, the need to take action is becoming increasingly urgent.

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# 1. INTRODUCTION

This document contains the Action Plan for the recovery of moose (*Alces alces americana*) in mainland Nova Scotia. The Action Plan identifies the tasks required to achieve the recovery objectives and is meant to provide a clear path forward for all partners involved in the recovery of mainland moose.

The overall goal identified in the Recovery Plan is to maintain the population of mainland moose in Nova Scotia within their current range and the identified objectives are to: 1) maintain and enhance the current population and distribution; 2) mitigate threats (where possible) that limit recovery; 3) initiate research to address priority knowledge gaps; and 4) maintain and enhance habitat (NS DNR, 2007). The priority tasks identified in this Action Plan in **Section 3** consolidate the recovery actions and approaches identified in the recovery planning table of the Recovery Plan (NS DNR, 2007). As in the recovery planning table, specific steps to achieve the priority tasks can be broadly identified as fitting into the categories of research, monitoring, management, education, or stewardship.

Recovery of mainland moose is complex and the need to take action is becoming increasingly urgent. As identified in the Recovery Plan, the species faces many threats including disease; habitat loss, fragmentation and alteration from development and forestry practices; poaching; vehicular collisions; climate change; and potentially an increase in toxic heavy metal uptake resulting from acidification (NS DNR, 2007). The severity of these threats and the interactions among them are poorly understood, though threats to habitat may be increasingly significant. Moose have complex habitat requirements that include a mosaic of woodland and wetland habitat types that provide food, shelter and appropriate thermal conditions (NS DNR, 2007; Parker, 2003). Specific spatial and temporal habitat preference and limiting factors are poorly understood. However, recent analysis indicates that moose in Nova Scotia may be subject to thermoregulatory stress during warm periods (Broders *et al.* 2012) and may rely on mature stands that provide adequate cover. These mature stands are becoming increasingly rare in the landscape, primarily due to forest harvesting practices (NS DNR 2007).

Many knowledge gaps remain and developing effective studies to fill these gaps presents considerable challenges. In particular, knowledge of basic demographic data is lacking and a reliable, efficient method for monitoring long term demographic trends is considered an urgent priority. Knowledge of the interplay of threats, the effect of trace element deficiencies and/or excesses, extent of illegal harvest, role of disturbance and other threats is also limited. Despite the challenges, a number of concrete management actions have been identified and progress has been made toward achieving some of the approaches identified in the Recovery Plan, as outlined in **Section 4**.

The recovery of mainland moose is particularly dependent on a strong commitment from the government of Nova Scotia, and the engagement of industry, private landowners and many partners. The need for government to play a strong leadership role in recovery is more crucial with moose than many other species at risk due to the species' large range, woodland habitats, and complex recovery needs, which require a significant funding commitment.

The likelihood of success from recovery actions may be tied to the effects of climate change in the province, which may exacerbate many existing threats. Warming climates can threaten moose both directly through heat stress and indirectly through a changing ecosystem which may cause increased mortality through factors such as higher levels of winter ticks infestations and increased parasitism of *P. tenuis* resulting from wider distributions of white-tailed deer (Lenarz *et al.*, 2009; NS DNR, 2007) . Increasing seasonal temperatures are already considered a major contributing factor to moose population decline in some southern parts of their range and declines are likely to increase as climates continue to warm (Lenarz *et al.*, 2009). While the impact of climate change in Nova Scotia is not yet understood, it could be a fatal blow to an already declining population. Given further refinement on climate change models for Nova Scotia, and the potential for impending increases in average annual temperature, it is conceivable that the long term persistence of moose on mainland Nova Scotia may not be possible, except in the most northern elevated areas. This may be a factor in determining which tasks are undertaken for moose recovery in Nova Scotia, especially given the high costs associated with some of the recovery initiatives.

## **2. The NOVA SCOTIA MI'KMAQ AND THE MAINLAND MOOSE**

The Mainland Moose is the last native ungulate in the Province of Nova Scotia. It is of significant traditional value to the mi'kmaq for food, social and ceremonial purposes that needs to be protected. To achieve this, the Recovery Team will work with the Mi'kmaq Moose Working Group to ensure the Mi'kmaq have a significant role in setting the priorities of tasks and actions and ultimately the recovery of the Mainland Moose.

### 3. ACTIONS COMPLETED OR CURRENTLY UNDERWAY

Limited progress has been made on a number of actions identified in the Recovery Plan (Table 1).

**Table 1. Summary of progress to date on actions identified in the Recovery Plan for Moose (*Alces alces*) in Mainland Nova Scotia (NS DNR 2007).**

#	Action identified in Recovery Plan	Progress to date	Status
1	Improve understanding of the weighting and interrelationship(s) of threats and limiting factors	St. Mary's University, in partnership with the recovery team, developed and submitted two funding proposals to the Natural Sciences and Engineering Research Council (NSERC). The proposals, which focused on multi-year projects to quantify impacts of human-magnified stressors on moose populations, received positive reviews but were unsuccessful in the competition. The proposals are unlikely to be resubmitted in their current form.	Completed
2	Improve understanding of habitat suitability, availability and selection	<p>Ectothermic response of radio-collared moose to changes in ambient temperatures was analysed and published (Broders <i>et al.</i>, 2012).</p> <p>The ectothermic responses of radio-collared moose were examined by NS DNR to define forest stand characteristics providing thermal cover for inclusion in a Mainland Moose Special Management Practices for forest harvesting.</p> <p>The Pellet Group Inventory protocol was modified to record (GPS) the locations of deer and moose pellet piles on the more than 500 transects distributed across the province. Locations can be related to the forest inventory, or revisited to measure stand characteristics.</p> <p>The Pellet Group Inventory is conducted annually using the revised protocols.</p> <p>Comprehensive field surveys of moose habitat in known population concentration areas is being undertaken to determine stand-scale factors important for moose habitat selection and use.</p> <p>Research examining moose occurrence records with stand and landscape structure is being undertaken by NS DNR with the Nova Scotia Community College's Applied Geomatics Research Group.</p>	<p>Completed</p> <p>Completed</p> <p>Completed</p> <p>Ongoing</p> <p>Ongoing</p> <p>In progress</p>

3	Improve efforts to provide insight into the structure and genetic profile of mainland moose	<p>Preliminary analysis of microsatellite data was conducted, indicating little current gene flow among mainland Nova Scotia, Cape Breton and New Brunswick populations and overall low variability on mainland Nova Scotia (Beazley <i>et al.</i> 2006). However, these analyses were conducted using relatively small sample sizes and the recovery plan identifies that further analysis is needed (NS DNR 2007).</p> <p>In 2010, 48 tissue samples were submitted to the US Forest Service Genetics Lab for a study on genetics of moose populations in North Eastern North America.</p> <p>A study examining genetic variability within and among moose populations from three mainland N.S. areas, as well as New Brunswick and Cape Breton Island, has been conducted. Tissue samples for DNA extraction, including antler cores, were analyzed with results yielding evidence for gene flow occurring only between the Tobeatic and Guysborough areas, and low genetic variability in all mainland areas. Further study is needed.</p>	<p>Partly completed</p> <p>Partly completed</p> <p>Partly completed</p>
4	Investigate the cause of death/illness in all found dead and apparent “sick” moose	<p>Post-mortem examination of all dead moose found is ongoing in partnership with Canadian Cooperative Wildlife Health Centre at the Atlantic Veterinary College, University of Prince Edward Island.</p> <p>Moose with neurological signs that can be humanely transported to Shubenacadie Wildlife Park are moved to the Park for a complete medical examination and recovery, if medically and financially feasible. Those that do not respond to treatment are humanely euthanized and necropsied.</p>	<p>Ongoing</p> <p>Ongoing</p>
5	Initiate a rigorous long-term monitoring program to provide reliable data on the distribution and demographics of moose on mainland NS	<p>NS DNR has undertaken several aerial surveys for mainland moose under winter conditions to estimate abundance. With the exception of the Chebucto Peninsula, the surveys did not provide reliable population estimates.</p> <p>Significant moose concentration areas have been identified based on occurrence records (NS DNR, 2012).</p> <p>Assessment of a new technique to estimate moose abundance in Nova Scotia is planned for the winter of 2013-2014. This technique, involving infrared aerial imagery linked to high resolution GIS capable cameras, has been successful in other jurisdictions (Millette <i>et al.</i>, 2011).</p> <p>The annual Pellet Group Inventory (PGI) is ongoing but, as currently implemented, was set up to monitor mainland moose population trends and was not designed to provide reliable population estimates. The efficacy of the PGI surveys has not yet been analysed and compared to other techniques.</p>	<p>Completed</p> <p>Completed</p> <p>Post-poned for budget reasons</p> <p>Not yet underway</p>

6	Establish a means of monitoring the impact severity of each factor (threat) known to inhibit growth of localized moose herd/ groups	Two funding proposals were developed and submitted to NSERC, as outlined in action #1. Both received positive reviews but were unsuccessful in the competition.	Not yet underway
7	Develop and implement a strategy to reduce poaching	NS DNR has undertaken enforcement efforts to reduce poaching with an intensive public education campaign focused in areas containing moose, the use of a mechanical decoy, and road signs that encourage reporting of poaching activities (NS DNR 2007).  The efficacy of efforts to reduce poaching is unknown. Anti-poaching efforts have led to several charges but there are no reliable methods of quantifying the effects of these efforts on rates of poaching (Mombourquette, pers. comm. 2012).	Ongoing  Ongoing
8	Decrease occurrence of preventable mainland moose mortality	Roadside warning signs and public education efforts have been undertaken to reduce the incidents of moose mortality on roads. This is particularly a concern in the Cobequid Pass where most incidents occur (Fudge <i>et al.</i> 2007). Two road signs have been posted in both the Cobequid Pass area, and in the Parrsboro area.  Through a partnership with NS DNR and the Federation of Anglers and Hunters, three deteriorating ramps were replaced and one new one constructed in bogs in Cumberland County in 2009. These ramps are designed to help moose escape from waterholes in an area where historical mortality has been documented (Rodgers 2009).	Ongoing  Completed
9	Determine the feasibility of translocating adult moose and/or orphans from New Brunswick and proceed as appropriate	Initial discussions have occurred within the recovery team but a decision has not been made on whether or not this is an appropriate management action and what source population would be most appropriate.	Not yet underway

10	Review and adapt forest management practices as habitat requirements of moose in Nova Scotia are better understood	<p>NS DNR approved a Special Management Practices (SMP) in August 2012 for forest harvesting activities on provincial crown lands within identified “Significant Population Concentration Areas” (NS DNR, 2012). The SMP requires maintenance of shelter patches for thermal cover, retention patches to provide cover within harvested areas, and the decommissioning of roads and access points when no longer required.</p> <p>Revision of the SMP and guidance to include landscape level metrics is underway.</p> <p>Work is underway to develop a landscape modelling framework to iteratively define and characterize moose habitat at multiple scales while allowing further investigation of habitat suitability, selection, occupation and connectivity.</p>	<p>Completed</p> <p>In progress</p> <p>In progress</p>
11	Raise public awareness of the status of mainland moose, threats, and recovery efforts	<p>A public awareness campaign was developed and delivered through directed efforts over the course of a year. The campaign is now ongoing opportunistically and moose are a primary focus of NS DNR displays aimed at ATV groups (Mombourquette, pers. comm., 2012).</p>	Ongoing
12	Promote public reporting of poaching and moose observations	<p>Reports of moose sightings and moose sign (scat, tracks) are encouraged through an online reporting form on the NS DNR website (<a href="https://www.gov.ns.ca/natr/wildlife/sustainable/msform.asp">https://www.gov.ns.ca/natr/wildlife/sustainable/msform.asp</a>)</p> <p>A paper reporting form is included in the Nova Scotia Hunting and Fur Harvesting Summary of Regulations booklet distributed with hunting licences (NS DNR 2007).</p> <p>Large roadside signs are displayed at all district NS DNR offices, encouraging the public to report observations of poaching (NS DNR 2007).</p>	<p>Ongoing</p> <p>Ongoing</p> <p>Completed</p>
13	Engage partners in recovery activities	<p>No systematic efforts have yet been undertaken to engage partners in moose recovery, though individual efforts have occurred, primarily by NS DNR staff.</p> <p>In 2012, NS DNR staff talked to several groups and industry representatives about the new SMP developed for moose</p>	<p>In progress</p> <p>Ongoing</p>

14	Engage landowners in stewardship of mainland moose and their habitats	<p>No systematic efforts have yet been undertaken to engage landowners in stewardship of moose and their habitats, though limited discussions have occurred</p> <p>NS DNR regional biologists have presented talks on moose conservation and the need for forest SMPs to community groups and with woodlot owners. They have also engaged individual landowners that have requested more information in managing their woodlots for moose.</p> <p>All environmental assessment applications filed under the Nova Scotia Environment Act are now required to consider moose in the context of their development. During the environmental review process, Wildlife Division biologists met with a number of development proponents in 2011 and 2012 , presenting information on the need for monitoring and the potential for aspects of the project to not get approval based on mainland moose considerations and encouraging involvement in moose stewardship.</p>	<p>Not yet underway</p> <p>Ongoing</p>
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## 4. PRIORITY TASKS AND ACTIONS

The recovery measures are meant to provide a blueprint for the recovery of mainland moose in Nova Scotia and have been broadly characterized into 5 inter-related tasks, each with associated sub-tasks:

1. Provide reliable data on the distribution, abundance and population structure of mainland moose in Nova Scotia.
2. Develop tools to support decisions in forest management planning at multiple spatial scales for moose habitat requirements.
3. Undertake studies on threats and limiting factors to enable an understanding of the causes of moose population decline.
4. Provide management strategies leading to the recovery of the moose population.
5. Raise public awareness, build partnerships and encourage stewardship of mainland moose in NS.

The tasks and their associated steps, rationale and deliverables are described in the following pages. While all actions identified in this plan are considered to be priority items, the Mainland Moose Recovery Team has identified a number of actions that are the highest priority to complete within the next five years. These highest priority items and their associated costs are identified in the action table listed under each task.

**Task 1: Provide reliable data on distribution, abundance, and population structure of mainland moose in Nova Scotia**

**Task Description and Rationale**

Accurate and timely information on the distribution and abundance of moose in mainland Nova Scotia is essential to understanding the threats affecting moose, designing management programs and evaluating successes. Monitoring efforts to-date involves two primary techniques; aerial surveys and Pellet Group Inventory (PGI) transects, both of which have limitations and have not provided reliable data on abundance. PGI surveys, which involve walking transects during spring to survey for moose pellets, provide information on changes in relative density over time but were not designed to estimate moose abundance (NS DNR, 2007). To be most effective, aerial surveys require winter snow cover, but in recent years, decreased snow cover and warmer winters often result in unsuitable conditions (NS DNR, 2007). Additionally, the effectiveness of aerial techniques varies with forest cover type. A new technique, involving infrared aerial imagery linked to high resolution GIS cameras, has shown promise in estimating moose abundance elsewhere (Millette *et al.*, 2011) and biologists at NS DNR are collaborating with the technique’s developer to determine its usefulness in Nova Scotia. Obtaining genetic data from pellet and/ or hair samples may provide additional data on population structure and allow for a non-invasive mark-recapture analysis in certain areas.

This high priority task involves several research projects to develop a reliable long term monitoring program for mainland moose in Nova Scotia. Undertaking this task will require partnerships with government, research institutions and external partners.

**Specific Steps**

Subtask	Actions	Highest priority?*	Cost **
1-1. Evaluate techniques to monitor moose populations	A. Test infrared aerial survey techniques for monitoring moose populations in Nova Scotia	✓	\$\$\$
	B. Evaluate the potential of extracting DNA from pellet and/or hair samples to provide mark-recapture data	✓	\$\$\$
	C. Examine existing PGI data and re-evaluate the PGI survey design	✓	\$\$+
1-2. Estimate abundance and develop monitoring strategy	A. Compare efficacy of monitoring techniques tested above to estimate current abundance and develop and implement a long term monitoring strategy	✓	\$\$+
1-2. Examine population structure in NS	A. Continue to investigate the genetic structure of N.S. mainland moose, and include an examination of the eastern mainland and Cape Breton populations to determine current level of gene flow among the two sub-species of moose.		
	B. Determine the feasibility of collecting and storing a subset of moose pellets encountered during PGI surveys for use in future analysis to refine knowledge of population structure and stressors.		
+ costs for this would mainly be staff time			

<p><b>Deliverables</b></p> <ul style="list-style-type: none"> <li>• Long term monitoring protocol for mainland moose in Nova Scotia</li> <li>• Current estimate of moose abundance in each of the four groups on mainland Nova Scotia</li> <li>• Regularly updated distribution maps</li> <li>• Publications in refereed journals</li> </ul>
<p><b>Links to Recovery Strategy</b></p> <p>This task addresses actions that fall under objective 3 in the Recovery Strategy, <i>initiate research to address priority knowledge gaps</i>. Specific actions addressed by this task include:</p> <ul style="list-style-type: none"> <li>• Initiate a rigorous long-term monitoring program to provide reliable data on the distribution and demographics of moose on mainland Nova Scotia</li> <li>• Establish a means of monitoring the impact severity of each factor (threat) known to inhibit growth of localized moose herds/groups.</li> <li>• Improve efforts to provide insight into the structure and genetic profile of mainland moose</li> </ul>
<p><b>Threats addressed</b></p> <p>While this task does not directly mitigate threats, it addresses significant knowledge gaps that are critical to understanding the magnitude of threats to mainland moose and the impact of potential mitigation on moose populations.</p>
<p><b>Audience and partners</b></p> <p>Target audience: Nova Scotia Government, recovery team, academics, Environmental consultants, land use planners, resource managers  Task lead: NS DNR  Partners: NS DNR, recovery team, academics</p>
<p><b>Funding strategy</b></p> <ul style="list-style-type: none"> <li>• Departmental funding already in place to test infrared aerial techniques (1-1A).</li> </ul>

\* While all actions are considered to be priorities, the ones checked as highest priorities will be the focus of recovery team activities over the five year period of this action plan.

\*\* Cost categories: \$ = < 10 000; \$\$ = 10 000-50 000; \$\$\$ = 50 000-100 000; \$\$\$\$=>100 000

## Task 2: Develop tools to provide decision support in forest management planning at multiple spatial scales for moose habitat requirements

### Task Description and Rationale

This task consolidates the information and guidance identified in the *Recovery Plan for Moose (Alces alces americana) in mainland Nova Scotia* respecting management of mainland moose habitat at multiple spatial scales. It will be achieved through two interrelated subtasks: 1) Develop a landscape modelling framework and tools for defining, characterizing, and integrating moose habitat and habitat related functions (e.g., connectivity) into forest management spatial programming systems and decision support structures; and 2) Conduct geo-spatial statistical analyses on existing and new data to define and explain variation in moose selection and use of habitat temporally and spatially at patch and landscape scales with respect to abiotic (e.g. geophysical, climatic, anthropogenic infrastructure) and biotic (e.g. stand composition and arrangement) variables.

Moose decline on mainland Nova Scotia has originated and persisted through a complex, and inadequately understood, range of interrelated factors. A key factor identified in the 2007 moose recovery plan (NS DNR 2007) is the influence of available habitat (Parker 2007). In response to its goal of maintaining the mainland moose population in Nova Scotia, the recovery plan lists the maintenance and enhancement of moose habitat as a primary management objective. The recovery plan calls for this objective to be achieved through increased understanding of the interaction of threats and limiting factors on quantitative measures of habitat suitability, availability and selection which can be integrated into decision support structures and tools for forest management planning to provide moose habitat at multiple spatial scales. This will involve active and passive approaches by crown, industrial and private landholders to address threats and limiting factors to population maintenance in the four disjunct moose concentration areas.

The most appropriate way to undertake this task is an integrated program involving government, industry and research institutions. Some aspects will require single consultancy contracts of limited duration. Consultation with corporate and private landowners will be an important part of the work.

### Specific Steps

Subtask	Action	Highest priority *	Cost*
2-1. Develop decision support structures and tools	A. Develop and apply a species-independent analytical framework for patch and landscape-level habitat suitability assessment.	✓	\$\$\$\$
	B. Employ ecologically appropriate landscape metrics, source data, analytical approaches, and software in a model for mainland moose habitat suitability.		
	C. Provide data summaries for key landscape metrics and environmental variables defining moose habitat at landscape scales, and written summary descriptions of analytical routines and data outputs.		
	D. Refine management practices to be specific as required for each moose concentration area and intervening areas.		
2-2. Describe spatial and temporal habitat requirements	A. Assess spatial and temporal habitat selection, movement, and use at multiple spatial scales employing GPS telemetry collars in the four moose concentration areas.	✓	\$\$\$\$
	B. Collate and analyze existing provincial data (e.g. pellet group inventories, radio and GPS telemetry).		
	C. Apply outputs to refine decision support structures and tools.		

### Deliverables / Evaluation of progress

- A species-independent analytical framework for patch and landscape-level habitat suitability assessment.
- A model describing spatial and temporal habitat needs of mainland moose integrated into forest management spatial programming systems and decision support structures.
- Special Management Practices specific to each moose concentration and intervening areas.
- Publications in referred journals

#### Threats addressed

Work undertaken in this task will help to provide the tools and knowledge required to address threats related to forest practices (5), climate change, and thermal stress (7).

#### Links to recovery strategy

This task addresses actions that fall under three objectives in the Recovery Plan: Objective 2 -*Mitigate threats that limit recovery*; Objective 3 -*Initiate research to address priority knowledge gaps* and Objective 4 -*Maintain and enhance habitats*. Specific actions addressed by this task include:

- Improve understanding of habitat suitability, availability and selection
- Review and adapt forest management practices as habitat requirements of moose in Nova Scotia are better understood
- Engage landowners in stewardship of mainland moose and their habitat

#### Audience and partners

Task lead: Nova Scotia Department of Natural Resources

Partners: MTRI, Port Hawkesbury Paper LP; Northern Pulp, Irving, NSCC-AGRG

Target audience: Nova Scotia Government, industrial forest companies, private land owners.

#### Funding strategy

- Departmental resources already allocated to develop framework and model (2-1A, 2-1B).
- Significant new funds will be required for completion of task 2-2.

\* While all actions are considered to be priorities, the ones checked as highest priorities will be the focus of recovery team activities over the five year period of this action plan.

\*\* Cost categories: \$ = < 10 000; \$\$ = 10 000-50 000; \$\$\$ = 50 000-100 000; \$\$\$\$=>100 000

### Task 3: Undertake studies on threats and limiting factors to enable understanding of the causes of moose population decline and improve ability to recover moose populations

#### Task Description and Rationale

Recovery of mainland moose is complex and the factors limiting the population are poorly understood (NS DNR 2007). As identified in the Recovery Plan, the species faces many potential threats including disease; habitat loss, fragmentation and alteration from development and forestry practices; poaching; vehicular collisions; climate change; and potentially deficiencies in trace elements and/or elevated levels of toxic heavy metal uptake resulting from acidification (NS DNR, 2007). The severity of threats and limiting factors, the interactions among them, and the variation across geographic regions remain largely unknown. Undertaking studies to fill these knowledge gaps is a priority identified in the Recovery Plan and the information is required to truly assess the population's potential for recovery and to develop recovery actions.

This task involves two primary components to begin to address these complex questions: 1) conducting a series of research projects designed to examine specific threats; and 2) modelling the relationships among threats. The latter may not be fully achievable during this five year action plan, but actions identified below will work toward this long-term goal. Work will be undertaken through partnerships with government and academic institutions and/or ENGOs and the involvement of industry and landowners will be sought.

#### Specific Steps

Subtask	Actions	Highest priority *	Cost**
3-1. Identify threats and limiting factors and quantify their impacts on moose populations	A. Continue to determine the causes of health problems and death in moose found sick or dead to determine endemic and emerging health issues and document long term mortality trends.	✓	\$
	B. Determine the involvement of secondary copper deficiency (i.e. excess dietary molybdenum, iron, zinc and/or sulfur excess) in the development of antler deformities and poor reproductive success already documented in the mainland moose population.	✓	\$\$
	C. Design and implement a study on calf mortality to determine its causes and whether or not it is a limiting factor in the poor reproductive performance documented in the mainland moose population.	✓	\$ (majority of costs incl. In 2-2A)
	D. Use existing data from PGI and aerial surveys to compare moose and deer distribution to determine if moose distribution is limited by the presence of white-tailed deer and the associated impact of <i>P. tenuis</i> .		
	E. Examine the effects of human induced disturbance from roads and trails on moose distribution and stress levels		
	F. Compare levels of stress with other, more stable populations of moose and determine if long term stress is a problem in Nova Scotia moose populations because long term stress is associated with decreased reproductive success		
3-2. Model relationships among threats	A. Compile existing information on threats and limiting factors		
	B. Engage experts from Nova Scotia and other jurisdictions to develop an achievable approach to modelling threats.		

#### Deliverables / Evaluation of success

- Summary of mortalities updated every three years
- Publications in refereed journals on each of the studies undertaken
- Database of existing information on threats for use in model development
- Report on threat modelling approach and feasibility
- Model framework to describe the interactions and relative severities of threats in each of the four subgroups

#### Threats addressed

Work undertaken in this task will help to provide the tools and knowledge required to address threats related to disease and parasites (1), access to moose habitat (3), and pollution (5).

#### Links to Recovery Plan

This task addressed actions that fall under two objectives in the Recovery Plan: Objective 2 *Mitigate threats that limit recovery*; and Objective 3 *Initiate research to address priority knowledge gaps*. Specific actions addressed by this task include:

- Improve the understanding of the weighting and interrelationship(s) of threats and limiting factors
- Investigate the cause of death/illness of all found dead and apparent “sick” moose
- Establish a means of monitoring the impact severity of each factor (threat) known to inhibit growth of localized moose herds/groups.
- Decrease occurrence of preventable mainland moose mortality.

#### Audience and partners

Target audience: Nova Scotia Government, recovery team, academics, industry

Task leads:

- 3-1A&B: Canadian Cooperative Wildlife Health Centre, Atlantic Region.
- Remaining tasks – NS DNR

Partners: NS DNR, recovery team, Canadian Cooperative Wildlife Health Centre, Atlantic Region

#### Funding strategy

\* While all actions are considered to be priorities, the ones checked as highest priorities will be the focus of recovery team activities over five year period of this action plan.

\*\* Cost categories: \$ = < 10 000; \$\$ = 10 000-50 000; \$\$\$ = 50 000-100 000; \$\$\$\$=>100 000

## ***Task 4: Provide and implement management strategies leading to the recovery of moose populations***

### **Task Description and Rationale**

While the many threats facing moose are complex and poorly understood, there are measures that can be undertaken concurrently with the studies identified in tasks 2 and 3 to begin to reduce specific threats. This task involves three management initiatives: 1) decrease known causes of mortality; 2) reduce threats to habitat and promote landscape connectivity; and 3) examine the potential for increasing recruitment. Many of the actions identified in this task are closely connected with task 5 as they require increased public awareness and strong partnerships among government, academic institutions, aboriginal organizations, ENGOs, industry and landowners.

Illegal hunting and vehicle collisions are the two main causes of direct human induced mortality and both are identified as a serious threat in the Recovery Plan (NS DNR 2007). Despite ongoing efforts anthropogenic mortality is still occurring, particularly vehicle collisions. This underscores the need for long-term comprehensive programs and increased collaboration with other government departments (e.g. NS Department of Transportation and Infrastructure Renewal) and external partners to address these threats.

The parasitic worm, *Parelaphostrongylus tenuis*, is another significant cause of mortality in the mainland moose population and has resulted in decline and even local extirpation of moose populations in other jurisdictions (Lankester 2010). White-tailed deer are the normal final host for this parasite but it is readily transmitted to moose though an intermediate gastropod host. The impact on moose populations is highest when conditions favour high densities of both white-tailed deer and gastropods in habitats where they are sympatric with moose. The potential for the transmission of the parasite to moose may be increased by climate change, particularly if it results in shorter milder winters that increase deer survival, and longer wetter summers that increase gastropod survival and disease transmission rates (Beazley *et al.* 2006, Lankester 2010). Management to reduce white-tailed deer populations in specific areas by increased hunting pressure may be beneficial in reducing this threat for moose (Lankester 2010).

Threats to habitat are complex and will ultimately require multi-stakeholder landscape level management. Despite many knowledge gaps in the role of habitat on moose decline, steps that can be taken to reduce known threats to habitat, including increasing connectivity among landscapes to facilitate gene flow and ensuring sufficient mature forest that provides thermal cover. A recent study suggested that moose in Nova Scotia may be subject to thermoregulatory stress during warm periods (Broders *et al.* 2012). The recently introduced Special Management Practices (SMP) is an attempt to begin to address this issue by requiring the retention of shelter patches when harvesting on crown lands (NS DNR 2012).

Captive rearing orphaned moose and/or translocating moose from another population are potential management actions that could enhance the population and increase genetic diversity. In addition, valuable data on habitat use survivorship, and mortality factors could be acquired by outfitting moose with GPS tracking collars when they are released. However, there are many factors that must be considered before taking this action including biological need for introductions, gene flow, likelihood of survival of translocated moose, potential for disease introductions, animal welfare issues and identification of the most appropriate source population (NS DNR 2007). This task will examine these factors and develop recommendations for future actions.

Specific Steps			
Subtask	Actions	Highest priority?*	Costs**
4-1. Reduce known causes of mortality	A. Continue anti-poaching campaign through awareness and enforcement efforts and increase partnerships with local organizations to reach a wider audience.	✓	\$\$
	B. Reduce risk of moose vehicle collisions by installing warning signs, and/or flashing messages where appropriate and by increasing awareness through annual media releases.	✓	\$\$
	C. Explore the feasibility of installing strategic fencing in high risk areas to reduce moose-vehicle collisions		
	D. Develop and implement a study to examine the effects of reducing white-tailed deer populations in certain areas to decrease transmission incidence of <i>P. tenuis</i> in moose, with management recommendations based on the findings.		
4-2. Reduce threats to habitat	A. Document compliance of forestry industry in adopting SMP and monitor impact of the SMP on forest stand structure.	✓	N/A (within government operations)
	B. Encourage private woodlot owners to adopt management practices that would benefit moose.	✓	N/A (within government operations)
	C. Work within government departments to explore ways to develop stewardship initiatives that encourage private landowners to adopt moose friendly practices.		
	D. Work within and among government departments to address conflicting interdepartmental agendas and develop resolutions for mandates that are in conflict (i.e. wildlife habitat needs vs. wood supply commitments).		
	E. Support the establishment of protected areas in the border region between NS and NB to maintain corridors which facilitate movement of moose between the two provinces.	✓	\$\$\$\$ (land trusts)
	F. Reduce disturbance of moose through public awareness and by encouraging decommissioning of forest roads and ATV trails, where feasible.		
4-3. Increase recruitment	A. Rear orphaned or injured moose calves found within NS and NB, and if healthy, release with radio collars to track survival.		
	B. Hold discussions with partners to identify if there is a biological need for translocation studies and, if so, develop report outlining recommendations.		
	C. Initiate translocation study, if appropriate, resulting from recommendations above.		
<b>Deliverables /Evaluation</b>			
<ul style="list-style-type: none"> <li>• Annual report documenting anti-poaching efforts</li> <li>• Regularly updated map of moose collision areas and report on collision reduction methods</li> <li>• Document outlining recommendations on translocation and/or captive rearing that identifies biological need, source populations and other considerations.</li> <li>• Report on options to develop and/or include the promotion of private land stewardship activities than benefit mainland moose recovery efforts</li> <li>• Report on the feasibility of initiating a study on reducing numbers of white-tailed deer as a means of limiting <i>P. tenuis</i> transmission to moose.</li> </ul>			

- Document reporting on implementation and compliance of SMP and recommendations for improvement.

#### Threats and objectives addressed

This task addresses threats of poaching (2), access to moose habitat and (3) forest practices.

#### Link to Recovery Plan

Actions identified in this task work toward fulfilling Objective 2 (*Mitigate threats that limit recovery*) and Objective 4 (*Maintain and enhance habitat*). Specific actions addressed by this task include:

- Develop and implement a strategy to reduce poaching
- Decrease occurrence of preventable mainland moose mortality
- Determine the feasibility of translocating adult moose and/or orphans from New Brunswick and proceed as appropriate
- Review and adapt forest management practices as habitat requirements of moose in Nova Scotia are better understood
- Promote public reporting of poaching and moose observations

#### Audience and partners

Target audience: Nova Scotia Government, industrial forest companies, private land owners, general public

Task lead: Nova Scotia Department of Natural Resources

Partners: NS Environment, academics, Nature Conservancy of Canada, ENGOs, Canadian Cooperative Wildlife Health Centre, Atlantic Region

#### Funding strategy

- 4-2A and 4-2B will occur within normal government operations (no additional funds required)
- 4-2E – fundraising for the costs to purchase and protect habitats will be the responsibility of land trusts (Nature Conservancy of Canada)

\* While all actions are considered to be priorities, the ones checked as highest priorities will be the focus of recovery team activities over five year period of this action plan.

\*\* Cost categories: \$ = < 10 000; \$\$ = 10 000-50 000; \$\$\$ = 50 000-100 000; \$\$\$\$=>100 000

## Task 5: Raise public awareness, build partnerships and encourage stewardship of mainland moose in Nova Scotia

### Task Description and Rationale

Successful recovery of species at risk typically requires the commitment of many partners and groups. In partnership with the Mi'kmaq Moose Working Group, the Recovery Team will develop mechanisms to involve the public to raise awareness; build partnerships involving government agencies, industry, private landowners and local organizations; and encourage stewardship of the Mainland Moose. This is particularly important for a species such as moose that occurs over a wide landscape and requires a variety of habitats. While recovery efforts to date have included some engagement and public awareness initiatives, primarily undertaken by NS DNR staff, much remains to be done. The Recovery Plan identified the need to more widely engage partners to both participate in moose recovery and deliver education initiatives (NS DNR 2007).

The Recovery Plan calls for the development and implementation of a communications plan which identifies target audiences, objective, priorities, key messages, delivery methods, performance indicators and timelines (NS DNR 2007). Elements of the communications plan could be undertaken by a variety of partner organizations and could explore novel ways to engage people in research and recovery efforts that are concurrently underway (e.g. encouraging communities to “adopt” released moose; reporting moose observations from game cameras etc.).

The long term goal is to manage the landscape across provincial, federal and private lands at the appropriate ecological scale for moose. While this may not be feasible in the five year timeline of this action plan, raising awareness, building partnerships and fostering “moose stewards” across the landscape will provide important first steps and will help to build public support for future recovery initiatives.

### Specific Steps

Subtask	Action	Highest priority *	Cost**
5-1. Engage partners in the stewardship of mainland moose	A. Host a workshop or open house in each of the regions where moose occur to foster relationships and discuss recovery efforts for mainland moose.	✓	\$
	B. Include Mi'kmaq involvement and TEK in the recovery process.	✓	
	C. Engage industry as partners in research on moose and forest management.		
	D. Work with private landowners to develop moose-friendly woodlot management plans.		
	E. Continue to encourage reporting of moose observations and poaching incidents.	✓	\$
	F. Develop and implement a low-cost citizen science program that will both engage people in moose stewardship and provide useful data to aid moose recovery.	✓	\$-\$\$
5-2. Raise public awareness of moose and the threats that they face	A. Develop and implement a strategic communications plan.	✓	\$ (development)
	B. Develop and distribute information package for private woodlot owners.		
	C. Partner with regional organizations to deliver local education initiatives about multiple species at risk, including moose.		
	D. Work with Service Nova Scotia to develop a moose license plate		

### Deliverables

- Communications strategy developed and made available to partners
- Annual report to the recovery team on stewardship and engagement efforts.
- Annual news releases in local media.
- Information package for private woodlot owners

#### Threats addressed

This task addresses threats of poaching (2), access to moose habitat (3), development (4) and forest practices (5).

#### Links to recovery strategy

This task works toward fulfilling Objective 2 (*Mitigate threats that limit recovery*), Objective 3 (*Initiate research to address priority knowledge gaps*) and Objective 4 (*Maintain and enhance habitat*). Specific actions addressed by this task include:

- Raise public awareness of the status of mainland moose, threats and recovery efforts
- Engage partners in recovery activities
- Engage landowners in stewardship of mainland moose and their habitat
- Develop and implement a strategy to reduce poaching
- Decrease occurrence of preventable mainland moose mortality
- Review and adapt forest management practices as habitat requirements of moose in Nova Scotia are better understood
- Promote public reporting of poaching and moose observations

#### Audience and partners

Target audience: Public, industry, partners

Task lead:

Partners: Nova Scotia Government, industrial forest companies, private land owners, Aboriginal organizations, ENGO's, hunting and recreational organizations

#### Funding strategy

- Partner organizations will be encouraged to develop funding proposals that address the stewardship of multiple species at risk.

\* While all actions are considered to be priorities, the ones checked as highest priorities will be the focus of recovery team activities over five year period of this action plan.

\*\* Cost categories: \$ = < 10 000; \$\$ = 10 000-50 000; \$\$\$ = 50 000-100 000; \$\$\$\$=>100 000

## 5. BENEFITS OF IMPLEMENTING THIS ACTION PLAN

Implementing this action plan is expected to have positive benefits for several stakeholders and partners. Positive impacts include direct economic benefits (e.g. increased revenue for educational institutions and NGO's leading to job creation), indirect economic benefits (e.g. skills development for students involved in research projects), as well as personal, spiritual, and cultural benefits (e.g. increased educational opportunities).

The recovery measures outlined in this document are expected to positively impact ecological integrity in the region by encouraging stewardship and sustainable management. Moose may be considered an umbrella species as managing the complex habitat requirements for moose requires a landscape level approach and has the potential to benefit many other forest species. As wide ranging ungulates, they may be important indicators of ecological health. Additionally, moose are a large charismatic species that are well known the general public and have the potential to be considered a flagship species for conservation in Nova Scotia. Moose hold special cultural significance to the Mi'kmaq who traditionally hunted them for food (Parker 2003). In general, biodiversity is valued for many reasons including cultural, spiritual, recreational, and economical and maintaining healthy ecosystems and promoting the sustainable use of biodiversity is an important element in Canada's Biodiversity Strategy (Minister of Supply and Services Canada 1995).

Mainland moose are a unique and valuable resource in Nova Scotia. If recovery is ultimately achieved to levels that permit hunting, moose will contribute to local ecotourism, generate revenue from hunting licences, and once again become a food source for Aboriginal groups (Parker 2003). Adoption of moose-friendly special management practices may benefit private and industrial land holders who seek to gain or maintain FSC certification.

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