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USING GEOGRAPHIC INFORMATION SYSTEMS TO ASSIST WITH THE INTEGRATED MANAGEMENT OF FORESTRY AND WILDLIFE HABITAT

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ABSTRACT

Forestry activities have substantial impacts on wildlife habitat, but there are few analytical tools to assist with the assessment of those impacts. Planning for wildlife habitat needs is a difficult task because many wildlife species move among forest stands to obtain resources. Therefore, wildlife managers must include the need for diversity of habitats over large (watershed-sized) areas in their planning. The development of geographic information systems (GIS) has made it possible to build analytical tools that explicitly incorporate the spatial aspects of wildlife habitat requirements into habitat plans.

The Habitat Assessment and Planning (HAP) tool, described here, is one such analytical tool that is currently under development as part of a cooperative project between the B.C. Ministries of Environment and Forests. An example of the way in which the tool can assist in making decisions about habitat management needs is given for the winter habitat of black-tailed deer.

INTRODUCTION

Habitat management is commonly used to achieve wildlife population objectives. However, wildlife managers frequently do not have control over the timing and placement of habitat manipulations that indirectly result from extensive forestry. Foresters have control but are often not aware of the effects of forestry on wildlife habitat. The resulting lack of integrated planning has often led to conflict. The Habitat Assessment and Planning (HAP) tool was developed specifically to aid in resolving one such conflict; the fate of old-growth forest stands that are deferred from harvesting because they are winter range for black-tailed deer (Odocoileus hemionus columbianus) and Roosevelt Elk (Cervus elaphus roosevelti). However, we believe that the HAP tool has general applicability to many wildlife species throughout British Columbia.

Timber development and habitat management often occur at very different "operational" planning horizons. Wildlife managers should plan over time frames of at least 20 years and base their activities on both stands and watersheds. Timber managers treat stands or small groups of stands independently. The differences in spatial scale occur because animals must move to obtain resources and trees do not.

Consequently area-based planning is less difficult for forestry than it is for wildlife. The Habitat Assessment and Planning (HAP) tool assists in the integration of planning for these two values.

INSTITUTIONAL FRAMEWORK

Initial development of the HAP tool has concentrated on the task of responding to 5 year "operational" forestry plans submitted by the companies to the Ministry of Environment for review and approval. Habitat Protection Biologists and Technicians from Ministry of Environment review the 5 year plans and suggest changes to the areas and scheduling of cutting to reduce the impact on wildlife habitat. This task is extremely complex and requires a good understanding of species habitat requirements, forest successional patterns and knowledge of local conditions. The current procedure is restricted in spatial and temporal scope yet it is time consuming and assessments of impacts on wildlife habitat are subjective.

Use of GIS and the HAP tool will help alleviate these problems by:

1. automating many of the manual aspects of the tasks;
2. identifying a small subset of the total area where site specific knowledge is critical; and
3. reducing the spatial and temporal complexity by modelling habitat quality.

CONCEPTUAL FRAMEWORK

The HAP tool has been designed as a mechanism that provides information to managers which they can use to make decisions. The tool itself will not make decisions. Decision making by managers will enable adaptive management procedures (Walters 1986) to be included in the process of habitat management.

In developing the HAP tool we have used the simplest models that provided useful results. An expert specifies those aspects of the system which he believes are important to the management goal. This approach makes development, application and validation of the models easier and it allows managers to easily understand, and therefore believe in, the system (Bunnell 1989).

"Game abundance should increase in situations where various types of food and over come together" (Leopold 1933). This concept is the core of the HAP tool. Previous attempts to incorporate habitat interspersion into wildlife planning, through the use of "interspersion indices" (e.g. Hienen and Cross 1983), were not adequate because they "added up" interspersion and did not represent the relationship among individual habitat polygons (stands). Adequate representation of spatial interspersion is possible only by processing habitat data while retaining its spatial integrity. This is only feasible through computerized map analysis (GIS).

DESCRIPTION OF THE HABITAT ASSESSMENT AND PLANNING (HAP) TOOL

The HAP tool is a series of micro-computer based models that allow forestry and wildlife managers to incorporate the spatial and temporal aspects of wildlife habitat into operational forestry plans and habitat plans. The HAP tool helps managers to:

1. assess wildlife habitat suitability and forestry impacts;

2. develop plans that minimize negative impacts and increase the benefit of forestry to wildlife habitat;

3. identify data gaps and the risk of uncertain management actions;

4. assess priorities for habitat management projects; and

5. document the rationale used to make decisions that affect wildlife habitat.

The HAP tool consists of 3 component parts:

1. a regional priorities model;

2. a watershed asssessment model; and

3. a management options model.

Each model has linked inputs and outputs that operate in an integrated and iterative fashion (figure 1). The regional priorities model is used to prioritize planning units (watersheds) in terms of the need for habitat management (McNay et al. 1987).

The watershed assessment model is then applied to each high priority planning unit. Watershed assessment is a stepwise and iterative process. In the initial step current habitat suitability, for a wildlife species, is assessed. Proposed forest harvesting scenarios are overlaid on the existing conditions and changes in vegetation through time are determined. The resulting habitat suitability under each scenario is compared with agency objectives. Input to the model includes large scale GIS data and proposed forestry plans. Model outputs are of 4 types:

1. Data gaps: stands where available data are not sufficient for a reliable assessment.

2. Sensitive Stands: stands where large changes in habitat suitability may result.

3. Future Forecasts: changes in habitat suitability through time.

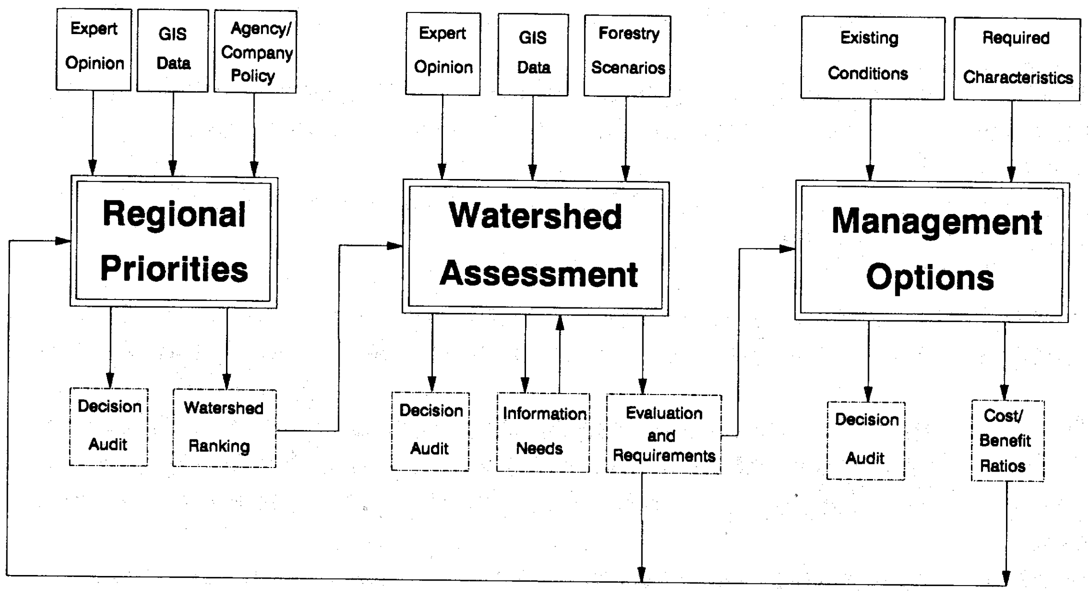

Figure 1. Framework for the Habitat Assessment and Planning tool.

4. Documentation: records of the results of the watershed assessment to aid in future evaluation of decisions.

If agency objectives are not met the management options model is used to obtain a relative cost/benefit ratio for the proposed management action.

WATERSHED ASSESSMENT PROCESS: AN EXAMPLE FOR BLACK-TAILED DEER ON VANCOUVER ISLAND

Winter habitat suitability for black-tailed deer was assessed for 11 000 hectares on southeastern Vancouver Island, British Columbia (described by McNay and Doyle 1987).

The first step in the watershed assessment process, evaluation of current habitat suitability, requires a model of winter habitat suitability for black-tailed deer as described in detail in Eng et al. (1989). The model (figure 2) is based on the following premises.

Snowfall on Vancouver Island exhibits a cyclic pattern with severe winters re-occurring at approximately 18 year intervals (Page 1990.) Therefore, for long-term population viability, black-tailed deer require access to habitat that will enable them to survive both mild and severe winters. We have found that accessability of severe winter habitat is influenced by the migratory behaviours of individual deer. Deer exhibit three different migratory behaviours. Obligate migrators (individuals that move at the same time of year regardless of weather conditions) will spend the winter on severe winter habitat (i.e. for those deer severe winter habitat must be adjacent to mild winter habitat). Year-round residents (individuals that do not migrate) will move up to 0.75 km from mild winter habitat to severe winter habitat. Facultative migrators (individuals that move from summer to winter range depending on day-to-day changes in weather conditions) will move up to 3.0 km from mild winter habitat to severe winter habitat (McNay and Doyle 1987).

Within a single day deer require food and cover (primarily stands that intercept snow thus maintaining the availability of forage). The quality of habitat increases as the distance between these two attributes decreases. The habitat quality of a given location is also constrained by its aspect and elevation. High elevation north facing slopes tend to receive more snow and retain it longer (i.e. lower quality) than do low elevation south facing slopes (i.e. higher quality). The suitability of a given location differs between years because deer require better snow interception cover during a severe winter than during a mild winter and deer movements are more constrained by deep snow during a severe winter.

Current vegetation cover was classified using the methods described by Klinka et al. (1984). Each plant association and successional stage was rated from 0.0 to 1.0 for its ability to provide forage and snow interception cover. Combined aspect and elevation classes were also rated from 0.0 to 1.0 in terms of the constraints they placed on the ability of current vegetation cover to provide deer habitat. Ratings were based on judgements of field biologists familiar with black-tailed deer in the area.

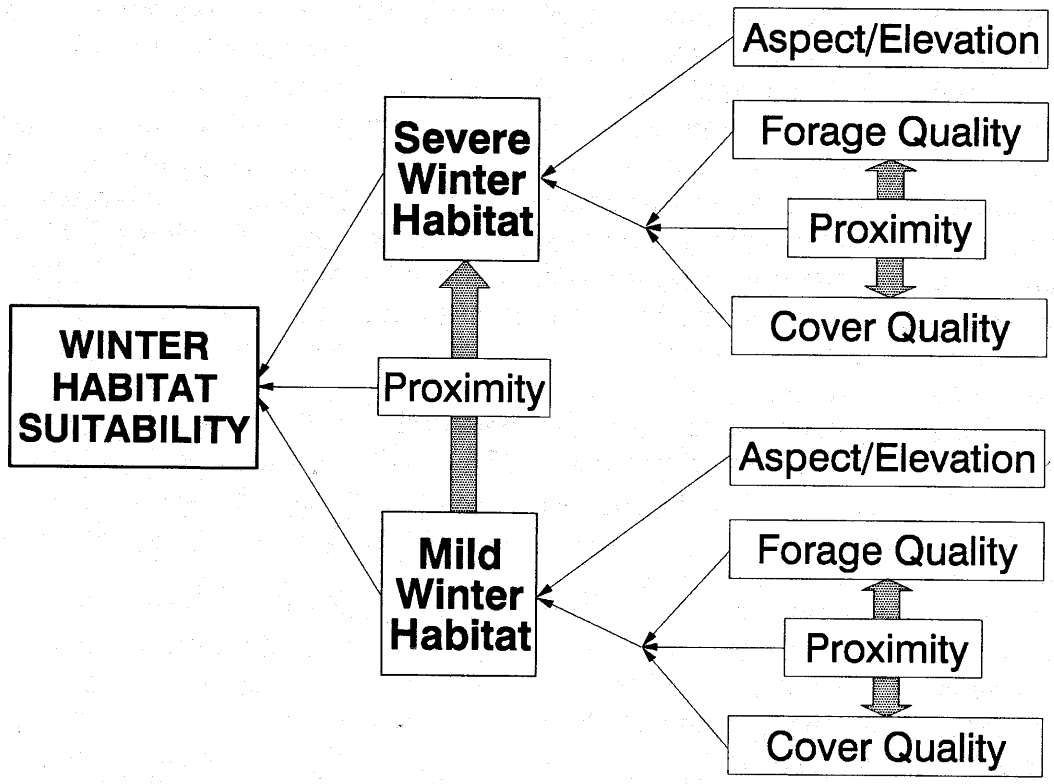

Figure 2. Winter habitat suitability model for black-tailed deer.

Distance buffers from high quality forage and high quality mild winter and severe winter cover were calculated. The distance buffers were rated in terms of the likelihood that a deer would move that distance in shallow or deep snow. In severe winters with deep snow deer are reluctant to move out of cover (figure 3).

To create the winter habitat suitability map, ratings for forage quality, cover quality and the distance buffers were combined using a complex averaging procedure and then multiplied by the rating for aspect-elevation. Each polygon was categorized as adequate or inadequate habitat based on the resulting value (inadequate <0.5< adequate). Map layers representing adequate severe and mild winter habitat were overlaid creating a composite winter habitat suitability map (figure 4). Distance buffers around adequate severe winter habitat that included adequate mild winter habitat within 0.75 km and 3.0 km represent the migratory behaviour types of black-tailed deer, as described above.

A proposed habitat manipulation, in which most of the remaining low elevation old growth would be harvested between 1990 and 2010, was then assessed. The successional stage of each stand was changed to simulate conditions at the year 2020. A reassessment of winter habitat suitability in 2020 was conducted using the methodology outlined above (figure 5).

If the objective was to maintain the current quantity and distribution of winter habitat at 2020, then this objective would clearly not be met (compare figures 4 and 5). The amount of adequate severe winter habitat will not decrease substantially from 1990 to 2020, even though most of the low elevation old growth will be harvested, because the model predicts that new severe habitat will develop at the edges between old second growth (which provide cover) and younger stands (which provide food). However, the amount of inadequate habitat will increase from 49.2% to 64.0% of the assessment area during the planning period and the amount of habitat suitable for supporting facultative migrators will decrease substantially. Deer winter habitat will be severely fragmented, particularly in the western portion of the assessment area.

OPPORTUNITIES AND CONSTRAINTS

The use of geographic information systems offers significant advantages over analog maps in the assessment and planning of wildlife habitat because daily and seasonal habitat interspersion requirements can be realistically modelled. Iterative assessments, comparing different scenarios, can be accomplished with minimal effort. The resulting output can be used to develop recommendations for changes to habitat manipulation scenarios and habitat enhancement programs.

However, there are several difficulties with the widespread application of this technology. Suitable models for management purposes (notably forest succession models) may be lacking and data may not be sufficiently detailed or reliable (current vegetation cover information). However, the most important difficulties relate to corporate and institutional attitudes:

1. effective use of the technology requires that wildlife managers explicitly

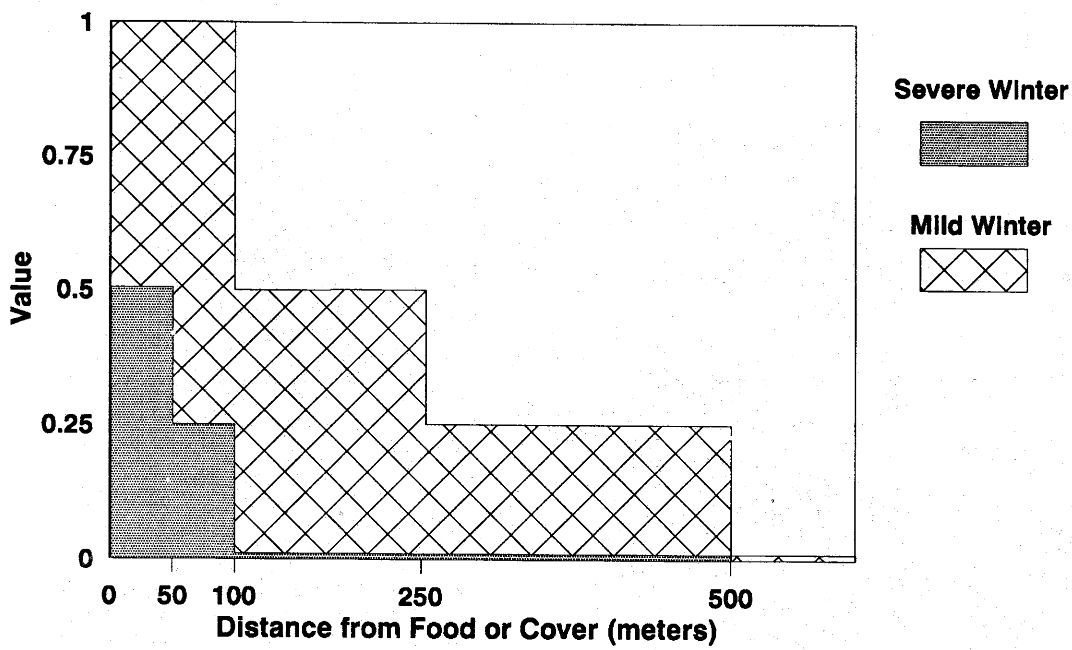

Figure 3. Model ratings for distance from food and cover during mild and severe winters.

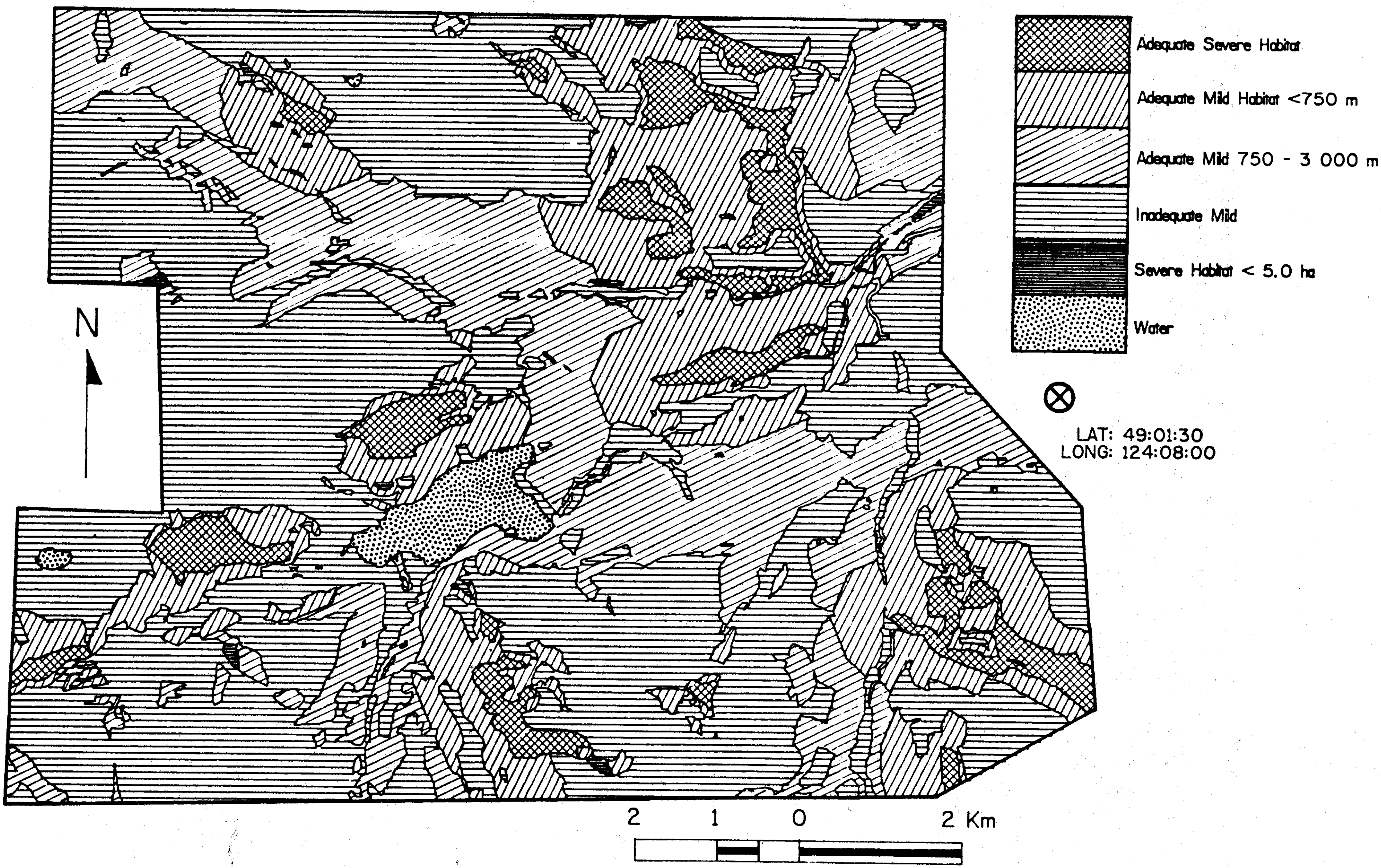

Figure 4. Projected winter habitat suitability map of the study area in 1990.

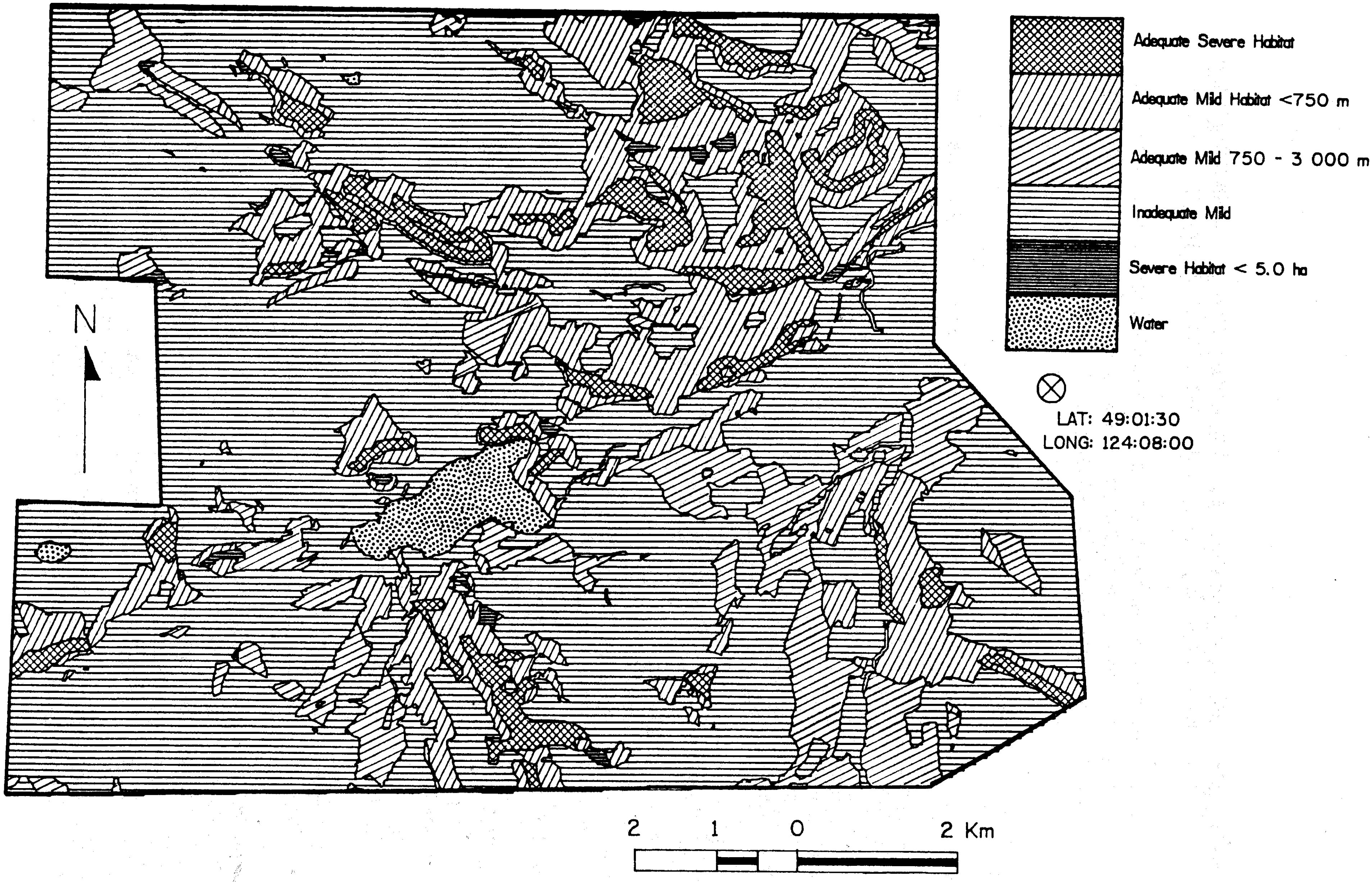

Figure 5. Composite winter habitat suitability map of the study area in 2020.

state their habitat objectives and develop methods of comparing those objectives to the objectives of other resource sectors; and

2. management at all levels of industry and government must be willing to accept the cost and short term reduction in staff productivity that will be associated with the implementation of the technology.

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