The Valuation of Wildlife Habitat in Manitoba Hydro's Assessment of the Wuskwatim Development

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Overview and Introduction

This presentation is about the places where a given species of wildlife lives, or its habitat. Understanding the relative value of different kinds of habitats to a species is the purview of the habitat scientist and habitat biologist. At its very rudimentary, this understanding represents a construct, or model, of a species habitat use. Beyond this, formal wildlife habitat models can range from something as basic as a verbal description of key elements and their relative importance, to models that have a high degree of analytical complexity and are based on local relevant data. However, habitat models are generally mathematical abstractions of the real world.

The **goal** of this presentation is to help the Commission understand something about

- the types of habitat models used to assess the impact of the Generation and Transmission Projects on wildlife,
- how Hydro's perspective on habitat models differs from that of scientists,
- how the scientific literature, and tests conducted in Manitoba, demonstrate that the habitat models used by Hydro for the Transmission assessment were inappropriate,
- why we might expect the habitat models used for the Transmission assessment to be inappropriate, and
- why it is not possible to accept the findings of the assessments on the Generation and Transmission components.

The **focus** of the presentation is on the models used for the Transmission assessment, for reasons that will become apparent later. For assessment of the transmission line, Hydro used the Manitoba Habitat Suitability Index (HSI) models developed by the Manitoba Forestry Wildlife Management Project (MFWMP).

Habitat models are generally mathematical abstractions of the real world. And technical discussion of such models speaks in the languages of modeling and statistics, using words like independent variables, r-squared, non-linear models, covariance, and interaction. This is the language of those few people who are strongly analytical by aptitude and nature. But it is not the language of the majority of us, and such talk in excess can only act as a sedative, rather than a means of communication.

Because each member of the Commission has years of experience and expertise in his or her own areas of interest, you will understand the importance of 'common sense'. And therefore it is the goal of this presentation to provide information in a form that will allow members of the Commission to apply that common sense to your deliberations on the subject at hand.

Background Expertise

I want to briefly introduce my relevant background, to give the Commission a sense of where I come from.

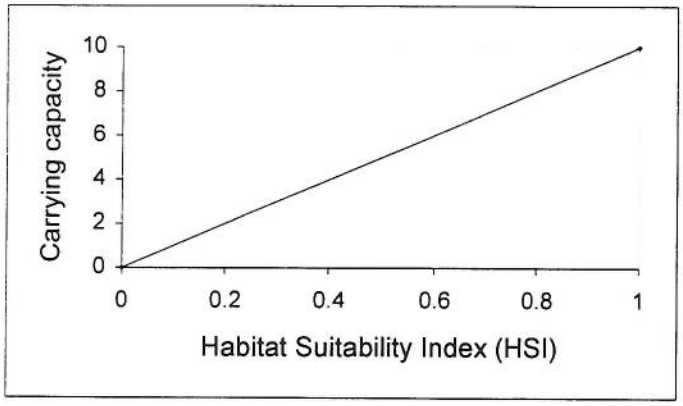
- One of my past lives was as the Population Ecology Biologist for Manitoba Wildlife Branch. This role as an applied 'Researcher' ended up being primarily one of 'Reviews ongoing programs of data collection to determine if they are relevant and of value.'. For example, one of my tasks was to examine how the Verme Weather Severity Index (WSI) was being applied by Manitoba Natural Resources. The Verme WSI was developed in Michigan to model the impact of winter weather on the survival and reproduction of white-tailed deer, and the findings of the assessment can can be found in Soprovich and Hristienko (1989). I also published a paper on a relatively complex stochastic simulation modeling exercise (Soprovich 1992).
- Between 1991 and 1995, I was the Regional Wildlife Biologist for the Western Region of Manitoba Natural Resources. While in that position, I represented the regions on a Technical Advisory Committee that had been in operation for some time, and was charged with the development of HSI models for forest wildlife. I embraced this task enthusiastically, with the hope that we would be able to develop habitat models that would truly value different types of forests for wildlife, and therefore be able to reasonably predict the impact of forestry operations. However, the process for development of these models has already been set, and there was limited opportunity to modify the overall modeling approach. During my time on the TAC, I participated actively, by conducting tests of the first models using data from my Region, making presentations, making recommendations to contract species experts to help with development, and cooperatively designing a test of the American marten model. However, after being involved in the development of 8 models, I left the Project for several reasons, one being that I had come to the conclusion that these habitat models were unlikely to perform to the level necessary for use in a management application. The main point that I wish to make is that I went into the process of developing the Manitoba HSI models with an optimistic and open mind, and, on the basis of the evidence over my time on the TAC, came to the conclusion that these models were unlikely to perform adequately.

The Manitoba HSI Models

The Manitoba HSI models were developed according to a method of the US Fish and Wildlife Service (see Figure 1-1 of USFWS 1981). The method requires that "The HSI has a minimum value of 0.0 which represents totally unsuitable habitat and a maximum value of 1.0 which represents optimum habitat." and that "An HSI model produces a 0-

1.0 index with the assumption that there is a direct linear relationship between the HSI value and carrying capacity." (USFWS 1981). This means that the relationship must be a line, and that a curve or some other relationship is not acceptable. And because the line must pass through what is known as the origin, or 0,0, it is not acceptable for the line to begin at a value greater than 0. Hydro applied the Manitoba HSI models according to a USFWS method known as HEP, which requires that the HSI model relationship be linear and through the origin. That is, the methodology (USFWS 1981) states "Specifically, the use of HEP assumes that, for any evaluation species, a unit change in HSI will always have the same significance (i.e., will always correspond to the same change of carrying capacity units). This relationship is depicted in Figure 1-1 ...".

Figure 1-1 (modified from USFWS 1981).



The goal in Manitoba was to use variables from the Forest Resource Inventory (FRI), that describe the forest, to predict habitat values, or HSIs, for a number of species.

Application of the HEP Method to Impact Assessment

The HEP method of assessment uses the HSI model, and the land areas involved, to determine the number of habitat units (USFWS 1981), or 'prime habitat equivalencies' as Hydro calls them. For example, we would rate 5 ha of habitat that has a HSI value of 0.2 to be of equivalent value to 1 ha of habitat with a HSI value of 1.0, because 5 times 0.2 and 1 times 1.0 both yield 1.0 habitat units.

Hydro's View of Failure in the World of Habitat Modeling

One of the questions that Manitoba Wildlands posed to Hydro (326d) was "For each of the species for which HSI models were applied, what evidence is there on the basis of tests in Manitoba to demonstrate that the model works or does not work?". Hydro's responses (EIS_RESPONSES_TO_QUESTIONS_COMPOSITE.pdf) were "The absolute nature of the question, with respect to whether the '*model works or does not work*' is inappropriate with respect to the application to the HSI models." (lines 12-13, page 1054) , and "... none of the models will absolutely fail." (line 19, page 1054).

These responses provide us with a glimpse of Hydro's perspective on what constitutes success and failure in the world of habitat modeling. And that perspective is so far removed from the human experience that it cannot receive serious consideration.

We are all familiar with models that … 'do not work' … 'do not perform as required' … 'fail'. It was once thought by some that the world was flat. That model has been rejected for some years. And we are also aware that, as Starfield (1997) stated in the context of wildlife modeling, "Like statistics, models can lie and mislead and modeling can be abused (Wallace 1994).".

Hydro's perspective is that there can be no such thing as failure in the world of wildlife habitat modeling. A world view where the concept of failure does not exist. For example, I go moose hunting, do not see a moose, and shoot myself in the leg. Hydro's view would be that I have not failed, but rather just not succeeded as well as I might have. Or I build a house, fail to understand the concept of load-bearing walls, and the house falls down. Hydro's view would be that I have not failed because I have learned something about load-bearing walls. I think that those of us who have been 'around the block' would reject Hydro's perspective.

The ability to predict is fundamental to any kind of success. For example, aboriginal people have been required to be able to predict where animals could be found, and how those animals would behave. Their very survival depended on their ability to not just predict, but to predict correctly. Similarly, the ability to predict correctly is central to the successful application of these HSI models.

Dr. Fred Bunnell (1989), one of the 'grandfathers' of wildlife habitat modeling, stated "One cannot evaluate the success or failure of a design attempt without specifying the demands–what task is the model to perform?". What a contrast of views between this expert and Hydro.

In the context of HSI models, 'what task is the model to perform?'. Given that Hydro has used the Manitoba HSI models to apply the HEP method, these models must be able to separate the good habitat from the poor, and the relationship must be linear and through the origin. If this is not the case, then the models 'do not work' for the task at hand.

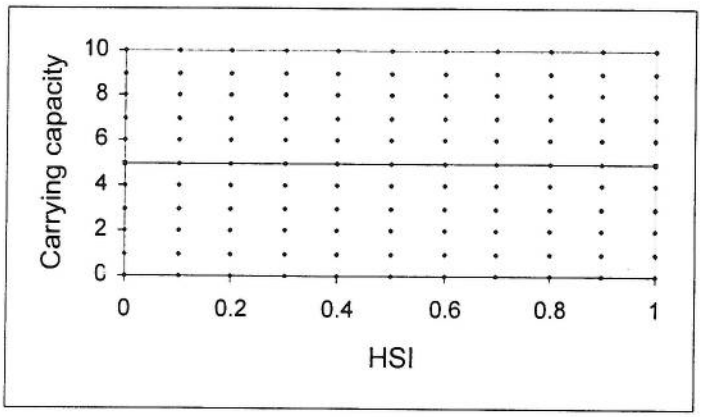
Random Variation in the Context of Testing an HSI Model

The following provides the Commission with an example of what a test might look like where a Manitoba HSI model has failed in its ability to predict habitat quality.

Let us say that we are interested in determining the effect of a development on American marten, a member of the weasel family that prefers old-growth conifer forest.

Let us also say that, instead of consulting with an expert on marten biology, using an available habitat model, or developing a habitat model, we instead rate the value of various forest stands by pulling a number out of a hat. Let us assume that we are rating

11 stands that are of zero value (true carrying capacity) to marten, 11 of value 1, 11 of value 2, etc. up to 11 stands of value 10. And let assume that, for each of these 121 forest stands, we determine their HSI as 0, 0.1, 0.2 etc. up to 1.0 when we pull the numbers out of our hat. We would expect the relationship between the true habitat value (carrying capacity) and our HSI to look something like this.



The slope of line is zero and it does not go through the origin. This is the kind of relationship that we would expect to see where there is absolutely no relationship between the true habitat value of a species and its HSI model habitat value.

In practical application, we essentially test to determine if the relationship is no better than simply pulling numbers out of a hat. Using test data, we use the science of statistics to estimate the probability that the slope of the observed line-of-best-fit actually differs from zero, and the probability that the intercept differs from the origin.

Hydro's View of the World of HSI Habitat Models vs That of the Scientific Literature

While involved in the development of the Manitoba HSI models, I became very concerned about the serious consequences of misapplication of these models. Several years after leaving the Project, I begin to examine the scientific literature on HSI models. Respecting the ability to apply HSI models in the manner done by Hydro, the literature indicated almost universal failure. In many of these tests, the models were not even capable of separating good habitat from poor. Therefore we see statements like the following in the scientific literature.

- Following a workshop on 'Bioenergetics and Estimation of Carrying Capacity', Risenhoover and White (1992) stated "Many felt that the value of the Habitat Suitability Index (HSI) technology, currently employed by many federal and state agencies, is flawed and of limited use.".
- "The performance of HEP models when tested with actual field data has been poor at best (Lancia et al. 1982, Bart et al. 1984) ..." and "The results of the present study should raise serious questions regarding the use of qualitative models, such as HEP, in monitoring and predicting the response of bird species (and perhaps other wildlife species) to changes in their habitat." (Maurer 1986).

- "In tests of HSI models for the spotted owl (Strix occidentalis), marten (Martes americana), and Douglas' squirrel (Tamiasciurus douglasii), we experienced poor results even though they were based on what was believed to be good information." (Laymon and Barrett 1986).

Note that two of these citations come from well before the start of the Project to develop the Manitoba HSI models.

For the purpose of this presentation, the recent scientific literature on HSI models was briefly examined. It appears that nothing has changed respecting their inability to perform. For example, we observe the following.

- For their test of an HSI model for mink, Loukmas and Halbrook (2001) stated "Correlation analyses determined that HSI values were not associated with degree of mink activity (r=-0.09, P=0.729), indicating that the model is not well suited to predict overall habitat quality in these areas.", "Our study indicated that the current mink HSI model cannot predict amount of mink activity along riverine systems in the Great Lakes basin of Wisconsin.", and "The current mink HSI model was not validated for use …".
- For a white-tailed deer HSI model developed by a forestry company in Saskatchewan, Rothley (2001) stated "The unreliable predictive ability of the model tested in this study emphasizes the caution with which HSI models should be applied …".
- A Louisiana waterthrush HSI model exhibited a general poor ability to separate used from unused habitat, and an inability to separate good from optimal habitat (Prosser and Brooks 1998).

The only HSI model that seemed to predict adequately was one for black bear (Mitchell et al. 2002). However, that particular model is the result of what appears to be years of data collection and modeling work by experts, which is considerably different from the majority of HSI models (e.g., in particular, the Manitoba HSI models).

The scientific literature is replete with tests demonstrating the failure of HSI models. And over the last decade plus (i.e., the most recent scientific literature), there are few publications on tests of HSI models. The lack of publications suggests that scientists are doing little work in this area. If there were frequent defensible examples of models that performed well, we would expect to observe scientists reporting on these examples.

Hydro's View of the World of HSI Habitat Models vs That of Local and other Canadian Expertise

"They are … potentially 'dangerous' in the hands of unqualified individuals.".
Risenhoover and White (1992) on HSI models,
in their summary of a workshop on 'Bioenergetics and Estimation of Carrying Capacity'.

In response to a proposal by Soprovich to test the Manitoba HSI models, a number of biology professors from Manitoba Universities provided letters of assessment. The following are some of the comments of these scientists.

- Dr. Albert Bush, Professor and Chair, Department of Zoology, Brandon University. 1999. Letter to Soprovich (appended). "As an individual with some 'modeling'

experience, models, in the hands of those who do not understand their limitations, scare me. I say this because too few people understand that models are simplifications of the real world.", "It is unfortunately a truism that equations and models impress many people who lack quantitative skills ...", and "... variables and assumptions are just what their names imply. They must, on the one hand, be shown to be influential and, on the other hand, must be 'ground-truthed' to show that they apply in 'real-world' situations. The uncritical application on untested models can be a very dangerous thing. To my knowledge, HSI models are very weak and quite suspect.".

- Dr. Mark Abrahams, Associate Professor, Department of Zoology, University of Manitoba. 1999. Letter to Soprovich (appended). "In my opinion, HSI's are indices, not models. This is a very important distinction, because the role of an index has always been to collapse a description into a single number, whereas a model is a general approach that seeks to describe and predict how an ecological system functions.", "Should HSI models really be considered a model that is an important management tool, they must be subjected to the standard rigours required." and "Throughout the HSI literature, reference is often made to "validation". The implication is that after the validation process, the model is now valid. Individuals farther removed from the development of the model, particularly managers and politicians, will then be misled into believing that the model has now achieved some magical property that makes it accurate and reliable.".
- Dr. James Hare, Assistant Professor, Department of Zoology, University of Manitoba. 1999. Letter to Soprovich (appended). "... I echo your concerns regarding the application of such models in resource management. Indeed, the assumption of linearity and pooling of multidimensional habitat data into singular dimensionless indices seem naive at best." and "Further, as you asset, the repeated failure of such models to map into observed differences in abundance across habitat of markedly different quality raises legitimate concern.".

In response to a proposal by Soprovich to test and develop the Manitoba American marten HSI model, Dr. Ian Thompson of the Canadian Forest Service provided a letter of assessment. Dr. Thompson is **the** expert when it comes to the habitat relationships of marten. The following represents some of his comments relative to HSI models.

- Dr. Ian Thompson, Research Scientist, Canadian Forest Service. 1997. Letter to Soprovich (appended). "Insufficient testing of these models has been done, especially in Canada. You might want to look at the Wildlife 2000 and Wildlife 2001 books for a few tests of HSI models ... Most of these tests fail. ", and "Generally, I am not supportive of HSI as an approach to forest management. However, in the absence of other more elaborate tools, it is an approach that can work as one component of a forest management program that also includes coarse filters, **if** the models predict correctly.".

So ... these are the perspectives of scientists who have reached the pinnacle of expertise in the biological sciences. In contrast to Hydro's perspective.

Performance of the Manitoba HSI Models

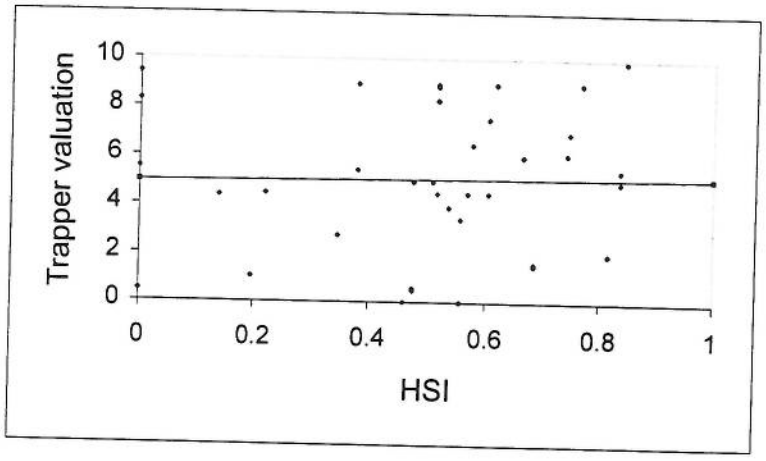
One of the questions that Manitoba Wildlands posed to Hydro (326a) was "Why did Manitoba Hydro/NCN apply the HSI model method … when there is ample evidence that the models developed for Manitoba do not work?". Hydro's response (line 11, page 1048) was "Evidence to support the statement that the models "do not work" is not available." (EIS_RESPONSES_TO_QUESTIONS_COMPOSITE.pdf).

The following will provide the Commission with a sense of the performance of the Manitoba HSI models, the evidence of which clearly refutes Hydro's response, and which has been available for years.

It is first important to illustrate why it is of fundamental importance to examine the performance of the Manitoba HSI models. While the scientific literature reports general failure of HSI models, there are HSI models … and **there are HSI models!!** The amount of time, resources, use of relevant data, and expertise dedicated to the development of a HSI model varies substantively. Therefore, even if the literature indicates general failure of these models, it is not outside the realm of possibility that the Manitoba HSI models might achieve the necessary predictive capability. Similarly, the fact that the odd HSI model reported in the literature might predict adequately is no assurance that the Manitoba HSI models would do so.

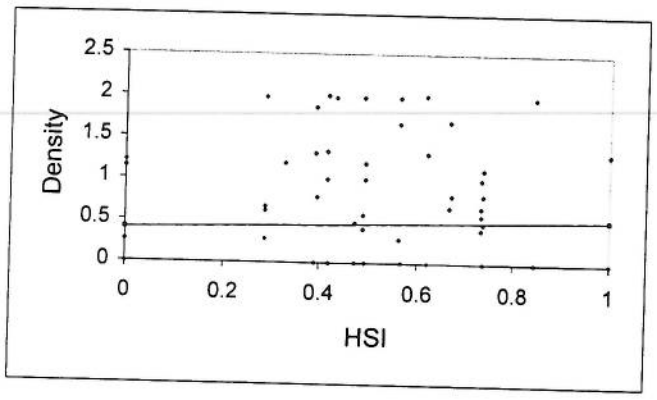
While involved in the Manitoba Forestry Wildlife Management Project, a colleague and myself designed a test of the American marten model. We chose to use habitat valuations by trappers as our test variable. On a scale from 0 to 10, trappers rated various forest stands on their trapline as to their habitat value for marten, and the HSI values of those stands were calculated according to the model.

This following figure represents the results from four trappers from the Manitoba Model Forest (Soprovich 1996). The line-of-best-fit is essentially flat ($P = 0.92$) and it does not go through the origin. In essence, what this analysis tells us is that we could have predicted habitat quality just as well by pulling numbers out of a hat, and that the model has failed to predict habitat quality. Similarly, when TetrES (1995) applied the marten model to a forest development, they concluded that "In general, model results were inconsistent with impacts anticipated on the basis of the professional literature. The marten model in particular does not conform to expected impacts …". The MFWMP also reported on the assessment with trappers. However, only about half of the data were selectively included in the analysis, and the overall HSI values were not related to the trapper evaluations.



Berger and Ehnes (1997) used bird occurrence data from the Manitoba Model Forest and surrounding area to test ten of the HSI models. They concluded that "None of the models performed adequately when evaluated against expected patterns of habitat use, use accuracy or when mean station density per stand was regressed against HSI value."

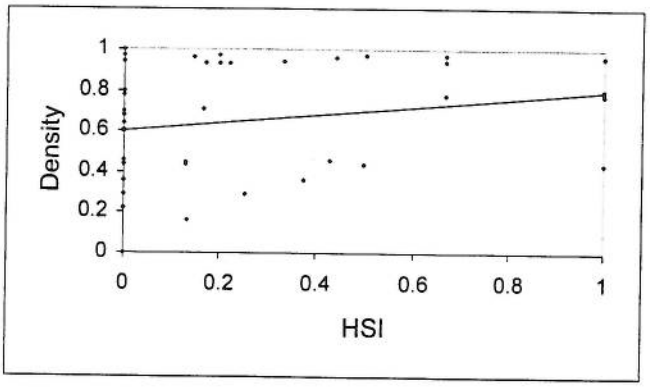
The black-and-white warbler is a small bird found primarily in broadleaf and mixedwood forests. The following figure represents the results of the test on this species.



As with American marten, we observe no relationship between the test variable, in this case some kind of density estimate, and the HSI. And again, the HSI model predicted habitat quality no better than if we had drawn numbers from a hat. Four of the bird models exhibited this kind of relationship.

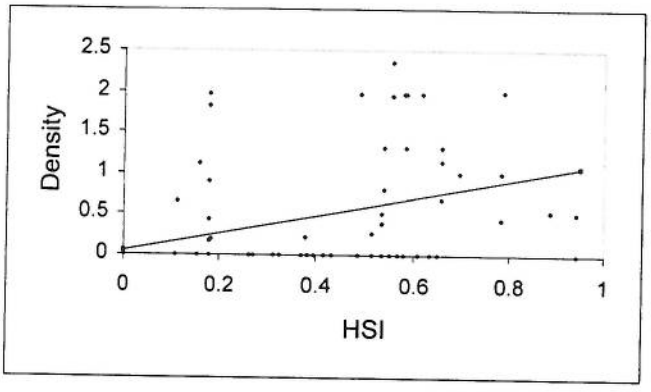
Note that the density of warblers found in habitat rated at 0.2 was almost equivalent to that of warblers found in habitat rated at 1.0. This relationship contrasts with the requirements of the HEP method, where the carrying capacity of the habitat rated at 1.0 is required to be 5 times that of the habitat rated at 0.2.

The hairy woodpecker is a medium-sized woodpecker found in forested environments throughout Manitoba. The following figure represents the results of the test on this species.



For this species, there appears to be some relationship between the test variable and the HSI, although the analysis indicated that there was a reasonable probability that this result was due simply to random chance. However, the figure strongly suggests that the line for the true relationship des not go through the origin, and therefore this model does not meet the requirement for its use according to the HEP method. Three of the bird models exhibited this kind of relationship.

Of the other three models tested, although the analysis for the ruffed grouse model suggests a linear relationship through the origin, the linear model is clearly not appropriate for these data (see figure below, a curvilinear model might be appropriate). Furthermore, using ruffed grouse data from Berger (1995), Soprovich had previously found the ruffed grouse model to fail. The other two bird models examined by Berger and Ehnes (1997) exhibited similar relationships to that of the ruffed grouse model. However, these models were for species whose primary habitat is not forest, and the tests of these models are likely of little relevance to this development.



Further to the above, Soprovich (1997) observed model failure for some of the Manitoba bird HSI models for an area near the Porcupine Hills of west-central Manitoba. For example, the Manitoba model for black-and-white warbler predicted relatively high quality habitat (HSIs) for black spruce and jack pine forests, habitats that were not used by the species in this area.

Other Manitoba HSI models that have been tested in one manner or another include the moose, caribou, barred owl, and great gray owl models. However, none of these models has been tested in a way that would support their application as Hydro has done. The test of the caribou model (Palidwor and Schindler 1995) did not examine the relationship between caribou and the overall HSI value, and was of limited use. Evaluation of the winter component of the moose model (Ticknor 1993), using density estimates, was unable to demonstrate the ability of the model to separate 'medium' (HSI 0.2-0.5) from 'high' (0.6-1.0) quality habitat at close to accepted statistical standards. Another evaluation, using some of the same data, suggests that the model might be able to separate 'medium' from 'high' quality habitat (TAEM 1993). However, for the purpose of evaluating the model as typically used, the study was fundamentally flawed, and would require clarification relative to some of their methodologies (e.g., the use of 'non-random' data, and the elimination of at least one datum). Finally, following their application of the moose model, TetrES (1995) stated that ""In general, model results were inconsistent with impacts anticipated on the basis of the professional literature.". The test of the great gray owl model (Duncan 1996a) suggested a weak ability to predict nesting habitat, and no ability to predict foraging habitat. The test of the barred owl model (Duncan 1996b) indicated an ability of the model to differentiate between used and unused habitat.

Use of Untested Manitoba HSI Models by Hydro

Not surprisingly, the use of untested models in a management application is viewed to be highly risky (Brooks 1997). Laymon and Barrett (1986) stated "We strongly discourage the use of untested models because they lack credibility.". Similarly, Berger and Ehnes (1997) cited three authorities when they stated that "These authors recommend that models should not be applied for management purposes until their predictive accuracy has been established for local conditions.". Despite the fact that there has been no testing of the Manitoba beaver, red squirrel, and white-tailed deer HSI models, Hydro used these models in their assessment.

Further to this, not one of the HSI models that Hydro used for their assessment has been tested for the ecoregions of the proposed development.

Examples of Recent Rejection of the Manitoba HSI models by Manitoba Conservation

The Commission should be aware of perspectives of at least some Manitoba Conservation staff.

Despite the lead role of Conservation in developing the Manitoba HSI models, there are a number of recent examples that demonstrate implicit or explicit rejection of these models by Conservation staff.

- Staff of the Northwestern Region are using locally-collected data to develop a habitat supply model, rather than using the HSI model for woodland caribou (Mr. K. Whaley. 2004. Pers. commun.)

- Rather than using the moose HSI model, Conservation staff applied a different methodology to develop a new model for the Western Region (Mr. G. Carlson. 2003. Pers. commun.; Mr. P. Hildebrand. 2003. Pers. commun.).
- The Manitoba marten HSI model is not being used because people feel uncomfortable that the model was developed in the absence of objective relevant local data (Mr. D. Berezanski. 2004. Pers. commun.).

Reasons for Failure of the Manitoba HSI Models

The question that must come to mind is 'Why do these Manitoba HSI models fail or perform poorly?'. Habitat models will only be as good as the applicability and quality of the available knowledge, and the ability of those building a model to apply that knowledge appropriately. The following addresses these elements.

Process Problems

As individuals with many years of experience, members of the Commission will recognize the critical relationship between process and success. Some process problems that relate to the development of the Manitoba HSI models are as follows.

With respect to the process of developing habitat models, we can turn to the wisdom of Dr. Fred Bunnell. Dr. Bunnell might be considered a godfather of modern wildlife habitat modelling. He has been working on habitat models for more than three decades, has a tremendous record of publication, and is currently a Professor at UBC and Chair in Applied Conservation Biology at the UBC Centre for Applied Conservation Biology.

In one of his publications, Bunnell (1989) noted that "Most models are developed by teams or for managers by researchers.". Where models are developed by teams, there are two key players, and these are the 'Manager' and the 'Researcher'.

The 'Manager' has a problem, and is seeking a model to help him or her make decisions. However, the Manager does not have the technical quantitative modeling skills necessary to successful model building. The 'Researcher' is a special kind of scientist who has the necessary quantitative modeling skills. The strength of such a modeling team is twofold. The Researcher brings the skills necessary to develop models that are technically sound. The Manager has specific knowledge and focus, and because the Researcher's inquiring mind may wander, serves to keep the Researcher on track..

'The tools make the man.'. Those of you who have made things with your hands, a bookshelf, a house, a painting or anything, will understand the wisdom of this saying. One needs the right tool for the right job. In the context of habitat models, the Researcher is the principal and indispensable tool.

When the Manitoba HSI models were developed, there was no one to fulfill the Researcher role, that critical quantitative person skilled in the development of models. The key tool for model development was missing. Several members of the group had the

aptitude and background to serve in that role, but were severely time-constrained and not able to do so. Further, because a determination had been made to develop the habitat models according to the HSI model process (USFWS 1981), there existed little flexibility with respect modelling. The truism 'We reap what we sow.' comes to mind.

When embarking on a study, a scientist will first examine the scientific literature. For example, when Soprovich developed a proposal to test the Manitoba HSI model for marten, 57 publications of relevance were cited. In contrast, it appears that there was no comprehensive literature search prior to embarking on the development of the Manitoba HSI models. There is no report documenting and assessing the literature. From a scientific perspective, this is like building a house without a design, or like going out on the trapline for 20 days without thinking about what you need for food or gas. Given that the Project began in 1990, even a cursory examination of the available literature would have demonstrated that scientists had found problems with these models. And perhaps a more rigorous approach for the development of habitat models would have been selected (e.g., including the involvement of a modeler).

Elsewhere, relevant local data have often been used in the development of HSI models (e.g., the tremendous amount of data used by Mitchell et al. (2002) for the ongoing development of their black bear model). This was almost never the case for the Manitoba models. And in the few cases where relevant data were considered, they were in a form that was of limited value to the development of the models.

The Manitoba HSI models were almost exclusively developed using information in publications from the scientific literature. Unfortunately, often the literature was not directly relevant to our Manitoba ecosystems. For example, the literature on marten included studies from the mountains where 4 meters of snow was not atypical, and from Maine where winter temperatures are nothing like what we experience. Only 2 of the 26 publications cited in the development of the model were from Manitoba (MFWMP 1994). Similarly, many of the publications cited in development of the black-and-white warbler model are for studies from the east coast of the US, with only 4 studies from the boreal forest. And all of those studies from the boreal forest are for ecoregions that are different from those where Hydro's development is proposed. The problem of transferability of information from one area to another was recognized by Brooks (1997) when he stated that "Models are typically developed … for a designated ecoregion.".

Elsewhere, HSI models might take years of development by species experts and/or modelers (e.g., Mitchell et al. 2002). In contrast, the Manitoba models were developed over very short periods, and sometimes with the involvement of species experts, but often in the absence of a species expert. For example, while background literature was available, the yellow warbler model was completed during a one-day workshop with four foresters and four wildlife or parks managers.

Driving Variables

The general poor and unacceptable performance of the Manitoba HSI models is also a function of limitations of the Forest Resource Inventory (FRI). HSI models that have been developed elsewhere will often include levels of detail that are simply not available within our Manitoba FRI. For example, a Louisiana waterthrush HSI model (Prosser and Brooks 1998) uses stream clarity and substrate, and the presence of overturned root masses, measures that would be collected during on-the ground data collection. In contrast, the variables available for the Manitoba HSI models were restricted to those interpreted from summer aerial photographs. For forested sites, these are essentially measures of the size of the trees, an indicator of openess, tree species composition, and quality of the site for growing trees. So we observe the following kinds of things that would have a bearing on the accuracy of model predictions.

Burned and logged forests exhibit tremendous differences. For example, a high density of standing dead trees is found after a burn, while there will often be only a few live trees remaining after a forest is logged. And there is no question that animals can detect the differences. But the Manitoba HSI models make absolutely no distinction between these two kinds of forest disturbances - they are valued equally.

Under natural conditions, white spruce will often come up below aspen, and eventually may become dominant as the aspen dies. Because the FRI was based on summer photography, understory white spruce components were never detected, and such forests have been typed by Conservation as pure aspen stands. Indeed, this has led to forest management problems in west-central Manitoba, because the logging company that cuts aspen has targeted these stands. For the purpose of modeling the value of habitat for wildlife, a pure aspen stand with no white spruce understory is different from that of one with a white spruce understory.

Habitat Models for the Generation Component

For their assessment of the Generation component of the proposed development, Hydro did not use the Manitoba HSI models to assess habitat values, or the HSI model development process (USFWS 1981). This begs the question "Why would Hydro use one approach for one part of their assessment and a different approach for another?". One hopes that the known failure of the Manitoba HSI models formed at least part of the basis for those involved in the Generation assessment to choose another course.

That said, one can only regard Hydro's assessment on Generation as 'Trust me' 'science'.

Where have we heard that before?

The habitat models built for the Generation assessment were similar to the Manitoba HSI models in that scientific literature and 'expert-based opinion.' formed their basis (Page 9-14 of Volume 6 of Wuskwatim Generation Project EIS 2003). Hydro stated, on Page 9-14 of Volume 6, "The sample design precluded the development of a quantitative model for each species." and "Although not tested statistically …".

Of fundamental importance is that Hydro provided absolutely nothing to demonstrate that these models would work. Remember the previous quotes from Laymon and Barrett (1986), Berger and Ehnes (1997), and Brooks (1997) to the effect that untested models should not be used, and that to do so for management purposes carries great risk. In fact, Hydro did not even provide verbal descriptions of these models, and it is therefore not possible to evaluate these habitat models in any manner whatsoever.

Hydro's approach on their assessment of Generation impacts is so foreign to the scientific method that it simply cannot be construed to represent science. Fundamental to the scientific method is the clear, open, and honest provision of methods and data for the purpose of objective peer examination. Hydro have not provided their methods, because they have not provided the 'guts' of their models. Hydro chose not to test their models statistically, and therefore, unlike the situation for some of the Manitoba HSI models, there is absolutely nothing to demonstrate whether the models work or fail.

Under these conditions, we can only treat their information as 'No data. No statistical tests. No description.', or ….. 'Trust me' 'Not science'.

To Summarize

To summarize, the following points are important.

On the Transmission assessment.

- The scientific literature indicates an almost universal failure of HSI models.
- Manitoba scientists and other Canadian expertise recognize the failure of HSI models and caution against their use.
- Hydro's view is 'out of touch' with that of the scientific community.
- For HSI models to be used as Hydro has done, the method requires that the HSI models exhibit linear relationships through the origin.
- Hydro has ignored the abundant evidence that the Manitoba HSI models fail. Generally, the evidence is that we often could predict habitat values just as well by picking numbers out of a hat.
- Hydro have applied untested models to their assessment, a practice that is not recommended.
- Recently, Manitoba Conservation staff have implicitly or explicitly rejected the use of the Manitoba HSI models.
- Given our understanding of how models should be developed, there is reasonable evidence to explain why the Manitoba HSI models would fail.

On the Generation assessment.

- The process applied in assessment of the Generation component cannot be construed to be applied science. This is so because Hydro has provided absolutely no means by which anyone could assess what they have done.

Conclusion

Therefore, the findings of Hydro's assessment on Transmission and Generation can only be rejected.

To End

Finally, this presentation concludes by addressing a question that the Comissioners have likely asked themselves at times, and that is

'Why am I here?'.

From my perspective, the short answer is rather obvious. And it is that Manitoba Hydro have evaluated the impact of the proposed development using methods that are clearly flawed, do not meet very basic standards of science, and that in all likelihood substantively underestimate the impact of their development on wildlife. And I am concerned about wildlife, and the need for decision-makers to have at their disposal the true impacts of development proposals.

But it is the big picture that I want to address at this moment. And from that perspective, my answer is "I do not know why I am here.". Hydro had many years to do this thing right. Yet with respect to the Generation component, Hydro has relied on the 'trust me' approach. And with respect to the Transmission component, Hydro chose an inexpensive approach, using HSI models developed according to a method that has been demonstrated to fail repeatedly within the scientific literature. And particularly troubling, Hydro chose to use the Manitoba HSI models where all the available evidence was that they were inappropriate for Hydro to apply as they did. Hydro have transmission lines throughout the north, and could have collected some of the basic data required to evaluate their impacts. For example, with respect to migratory birds. One can only wonder 'Where were they all that time?'. I should not have to have been here.

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23 November 1999

Mr. Dan Soprovich
Bluestem Wildlife Services
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Swan River, MB
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Dear Dan:

Having read your brief proposal on the evaluation of HSI models, I echo your concerns regarding the application of such models in resource management. Indeed, the assumption of linearity and pooling of multidimensional habitat data into singular dimensionless indices seem naïve at best. Further, as you assert, the repeated failure of such models to map into observed differences in abundance across habitat of markedly different quality raises legitimate concern.

Despite those concerns, ongoing pressure to harvest resources and the availability of index data for a variety of species and systems, render it a certainty that both provincial and federal agencies will use such models to regulate resource harvest. Thus it is imperative that a comprehensive review, such as the one you propose, be undertaken to evaluate the limitations and utility, if any, of the models and their constituent data. Only after such a review is available will we even begin to be able to set confidence limits on estimates derived from such modeling.

It is my hope that your efforts will provide greater insight into habitat/resource relationships in general, and that your review will reveal more reliable methods to predict the outcome of proposed harvest or mitigation efforts. I endorse and applaud your attempt to move management in this arena toward more responsible environmental stewardship.

Sincerely yours,

Dr. James F. Hare
Assistant Professor of Zoology

Natural Resources Canada
Canadian Forest Service

Ressources naturelles Canada
Service canadien des forêts

Your file Votre reference

Our file Notre reference

March 20, 1997

Mr. Dan Soprovich
Bluestem Wildlife Services
P.O. Box 1442
Swan River, Manitoba
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Dear Dan,

I have reviewed your proposal for a study on marten with a testing of the Manitoba marten HSI model. I believe that this kind of study is essential if forest managers insist on using this type of model to drive their planning system. Insufficient testing of these models has been done, especially in Canada. You might want to look at the Wildlife 2000 and 2001 books for a few tests of HSI models (although not of marten). Most of these tests fail. But, this is not surprising because HSI reduces the complex action of habitat selection to 3 variables (perhaps 5), generally assumes some linear or step function between variable and response for what is certainly a nonlinear response, and provides a static aspatial solution to a continuous spatial problem.

Generally, I am not supportive of HSI as an approach to forest management. However, in the absence of other more elaborate tools, it is an approach that can work as one component of a forest management program that also includes coarse filters, if the models predict correctly. I have urged all of the Provinces that I deal with on a regular basis to test their HSI's as a standard procedure as part of an adaptive approach to the problem.

The only major modification that I would make to your proposal would be to fully spell out the sampling regime that you foresee (numbers of transects ie., sample sizes, placement of transects, frequency of monitoring), state the null hypothesis and state the model that you would use to test that hypothesis. In conclusion, I fully support your proposal because the work needs to be done, particularly in light of the TetRES report. I suggest that you approach the Model Forest as a possible funding source.

Yours truly,

Ian D. Thompson
Research Scientist

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November 1, 1999

Mr. Dan Soprovich
Bluestem Wildlife Services
P.O. Box 1442
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Dear Dan,

I have had the opportunity to read your proposal for evaluating Habitat Suitability Index (HIS) Models that are used in Manitoba. In my opinion, HSI's are indices, not models. This is a very important distinction, because the role of an index has always been to collapse a description into a single number, whereas a model is a general approach that seeks to describe and predict how an ecological system functions.

Should HSI models really be considered a model that is an important management tool, they must be subjected to the standard rigours required. A very good recent treatment of this approach was written by my colleagues, Professor Marc Mangel (UC Santa Cruz) and Ray Hilborn (UBC) in a book titled "The ecological detective: confronting models with data". They not only describe how to objectively confront a model with data, but also discuss issues such as model complexity. While HSI models are extremely simple and therefore easy to apply, they suffer from the problem of being so simple that they may leave out important components of the system. A thorough and open-minded review of this approach is necessary to determine whether additional parameters can significantly improve their performance.

One other concern I have with HSI models is their culture. Throughout the HSI literature, reference is often made to "validation". The implication is that after the validation process, the model is now valid. Individuals farther removed from the development of the model, particularly managers and politicians, will then be misled into believing that the model has now achieved some magical property that makes it accurate and reliable. Another important function of your review should be to demonstrate the reasonable limitations and weaknesses of these models.

I wish you good luck with this important and timely proposal.

Sincerely,

Mark Abrahams
Associate Professor

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28 October 1999

Dan Soprovich
Box 1442
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Dear Dan:

Thank you for affording me the opportunity to read your proposal to evaluate HSI models. I found your proposal to be well conceived and 'to the point'. In short, I like it and hope that you secure the necessary funding to pursue your objectives.

As an individual with some 'modeling' experience, models, in the hands of those who do not understand their limitations, scare me. I say this because too few people understand that models are simplifications of the real world. As such, models are based on assumptions about what are perceived to be the important, indeed overriding, variables. It is unfortunately a truism that equations and models impress many people who lack quantitative skills, perhaps because they believe in the infallibility of mathematics. While it is true that mathematics is largely an exact science, variables and assumptions are just what their names imply . They must, on the one hand, be shown to be influential and, on the other hand, must be 'ground-truthed' to show that they apply in 'real-world' situations. The uncritical application on untested models can be a very dangerous thing. To my knowledge, HSI models are very weak and quite suspect. The reliance on a linear relationship between K and HSI values certainly raises a 'flag', at least in my opinion. That, coupled with those simulations showing that the HIS models appear to be flawed, suggests to me that such models should be ignored without rigorous testing.

Your proposal would appear to provide such a test and I endorse it strongly.

Sincerely,

Albert O. Bush
Professor and Chair