Conservation Planning for Waterbirds and Wetlands in NE British Columbia: A Summary of the Preliminary Results from the Fort Nelson Project, 2003-2004

Prepared by

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Executive Summary

The western boreal forest covers more than 300 million hectares in western Canada and stretches across four provinces and three territories. This area supports 12-14 million breeding ducks annually, and is considered by Ducks Unlimited as one of their highest priorities for conservation planning efforts. Increased interest in extracting valuable resources from the western boreal forest, combined with the lack of information regarding waterbird (e.g., ducks, geese, swans, loons) and habitat relationships in this region, underscore the necessity of developing sound conservation strategies to protect critical wildlife habitat. This is especially important since effects of extraction activities on boreal wetland ecosystems remain largely unknown. Ducks Unlimited, through our Western Boreal Program, has been striving towards landscape conservation planning that includes protecting habitat, and enhanced sustainable development practices throughout the western boreal region. Our primary goal is to establish a sound conservation plan to ensure critical waterbird habitat is conserved through the development of a habitat model derived from satellite imagery and relative waterbird abundance estimates. This model is intended to predict important waterbird habitat at a large scale.

In 2004, we conducted aerial waterbird surveys on 153 randomly selected wetland basins to document breeding pair estimates for surveyed wetlands for early and late nesting species of waterbirds. Based on our observations, there were 498 breeding pairs on 1,022 hectares of water surveyed. We also surveyed 160 basins during three time periods (late August to early October) to document the relative abundance of migrating waterbirds present in surveyed areas. We surveyed about 25,000 hectares of water and observed approximately 47,000 ducks, geese and swans. We will continue to conduct surveys in 2005 and produce a final report based on 3 years of waterbird data.

To date, we have examined in detail the relationship between waterfowl abundance densities and wetland basin size classes. Using this significant relationship, we developed a fuzzy-logic modeling approach to predict waterfowl abundance. Next, we calculated the expected waterfowl abundance for each basin in the project area larger than one hectare. We used this preliminary modeling output to identify important habitat areas throughout the project area. As more information about the project area becomes available (water chemistry, surficial geology, 2005 waterbird surveys), and additional analyses are performed on the existing data, the model will be
refined and updated to provide the decision tools for resource managers in the Fort Nelson project area.

Ducks Unlimited has established an integrated research program, and solid partnerships with, Non-Government Organizations, Government Agencies, Universities, Aboriginal Peoples, Industry, and others to ensure that boreal wetland ecosystems remain functional and productive for wildlife for many years to come. Ducks Unlimited believes this goal is consistent with and complementary to Government and Industry’s goal of a developed, yet sustainable forest ecosystem.

**Introduction**

Ducks Unlimited established the Western Boreal Program in the summer of 1997 to: 1) identify critical wetland habitat throughout the western boreal forest (Figure 1); 2) to develop conservation strategies to protect these areas from development, which is occurring rapidly in this area; and 3) to ensure the western boreal forest remains a connected mosaic of habitats. Although our focus is on conserving habitat for waterbirds, benefits to a variety of wetland and upland-dependent wildlife including plants, amphibians, birds and mammals also occur.

The northeastern portion of British Columbia is considered an important area for migrating and breeding waterbirds; however, there is a lack of information on many species of birds and other wildlife in this region. Therefore, to obtain waterbird information, we conducted aerial surveys in this area in 2003-2004, and are planning to conduct surveys again in 2005. These survey data along with habitat information derived from LandSat Imagery (see Ducks Unlimited 2003) are being used to develop a model to predict waterbird density and distribution, and to help identify important habitat using a fuzzy logic modeling approach (Zadeh 1994). This information will then be incorporated into a larger model involving more predictor variables (e.g., water chemistry, fire, anthropogenic disturbances) to develop a conservation plan for wetlands and waterbirds.

By conducting collaborative research in the Fort Nelson, British Columbia area, the results will not only serve the needs of local residents and resource managers, but will also be a key component of Ducks Unlimited’s newest conservation program, the Western Boreal Program.
Research Goal and Objectives

Our goal is to establish a sound conservation plan to ensure that critical waterbird habitat is protected from effects of development activities. Our objectives are to:

1) To document waterbird densities on a randomly selected number of wetland basins.
2) To assess the relative importance of wetland and upland habitat types to waterbird communities.
3) To predict important wetland and upland habitats for breeding and staging waterbirds.
4) To zone areas of importance to waterbirds.

Project Area

The Fort Nelson project area is located in northeastern British Columbia (59°06’57 N, 122°21’22 W), and overlaps the eastern edge of the Yellowstone to Yukon corridor (Figure 2). The 3.5 million hectare (9 million acres) project area encompasses the transition zone between the predominantly spruce forested Taiga Plain and the Boreal Cordillera in northeastern British
Columbia (Ecological Stratification Working Group 1996). The project area includes portions of 3 ecoregions: the Muskwa Plateau, the Hay River Lowlands and the Northern Alberta Uplands, as well as a portion of the Muskwa-Kechika Management Area, and 6 ecodistricts (as defined by Ecological Stratification Working Group 1996). Five ecodistricts all in the Taiga Plains ecozone were investigated during 2003 and 2004. Ecodistrict and wetland information is provided in Table 1. The dominant landscape features include the foothills of the northern Rockies, Kotcho and Maxhamish Lake, and the Nelson, Muskwa and Prophet Rivers. This ecozone represents one of the most heavily utilized migratory waterfowl corridors in North America (Ecological Stratification Working Group 1996).

Figure 2. Location of the Fort Nelson project area in relation to the province of British Columbia, the Y2Y ecoregion, and the Muskawa-Kechika Management Zone.
Table 1. Ecodistrict sizes and related wetland information for the Fort Nelson Project, British Columbia.

<table>
<thead>
<tr>
<th>Ecodistrict</th>
<th>Ecodistrict Area (ha)</th>
<th>Total Wetlands(^1)</th>
<th>Total Wetland Area(^2) (ha)</th>
<th>Total wetlands (1-300ha)</th>
<th>Total wetland area (1-300ha)</th>
<th>Total wetlands (301-3000ha)</th>
<th>Total wetland area (301-3000ha)</th>
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</thead>
<tbody>
<tr>
<td>244</td>
<td>1,409,636</td>
<td>4,344</td>
<td>21,850</td>
<td>4,342</td>
<td>20,244</td>
<td>2</td>
<td>1,606</td>
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<tr>
<td>247</td>
<td>156,975</td>
<td>266</td>
<td>3,813</td>
<td>264</td>
<td>2,702</td>
<td>2</td>
<td>1,111</td>
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<td>248</td>
<td>1,138,169</td>
<td>2,865</td>
<td>30,764</td>
<td>2,860</td>
<td>14,848</td>
<td>5</td>
<td>15,916</td>
</tr>
<tr>
<td>249</td>
<td>492,492</td>
<td>1,369</td>
<td>16,763</td>
<td>1,365</td>
<td>13,565</td>
<td>4</td>
<td>3,198</td>
</tr>
<tr>
<td>252</td>
<td>318,477</td>
<td>156</td>
<td>631</td>
<td>156</td>
<td>631</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>3,515,749</td>
<td>8,991</td>
<td>73,821</td>
<td>8,978</td>
<td>51,990</td>
<td>13</td>
<td>21,831</td>
</tr>
</tbody>
</table>

\(^1\) Total number of wetlands (>1 ha) delineated from earth cover maps. We eliminated basins classified as 100% wet graminoid, and basins with less than 1 ha of open water from the sample universe.

\(^2\) Total wetland area for wetlands >1 ha. We eliminated basins classified as 100% wet graminoid, and basins with less than 1 ha of open water from the sample universe.

**Methods**

*Earth Cover.*—In 2001, we obtained 1999 Landsat 7 Enhanced Thematic Mapper satellite imagery with a spatial resolution of 30m x 30m and classified the image into 29 habitat classes, including 5 wetland classes. In the summer of 2001, we verified habitat classifications by conducting on-site evaluations of 603 sites. The classification scheme was based on Viereck et al. (1992), but was modified to represent the earth cover communities found in British Columbia. The overall accuracy of the mapped categories was 86% (± 5%). A detailed description of the earth cover inventory is provided by Ducks Unlimited (2003).

*Wetland Basin Selection.*—We used a random proportional allocation method, stratified by eco-district, to select wetland basins for aerial surveys. A new set of wetland basins was randomly selected for each year of the project; however, to ensure that we could address temporal changes in waterbird use, we randomly selected 20% of the wetland basins to be surveyed each year. For pair surveys, we surveyed randomly selected wetland basins between 1 and 300ha. We excluded wetland basins < 1ha to reduce risks of misclassification (e.g., terrain shadow, misclassified pixels), and wetland basins over 300ha were omitted due to safety reasons. During staging surveys, we surveyed a separate set of randomly selected basins. The number of wetland basins selected for each type of survey was based primarily on logistical and budgetary
constraints. A detailed description of wetland basin site selection is provided by Ducks Unlimited Canada (2004).

Waterbird Surveys.—We used a Bell 206B helicopter for breeding pair surveys, and a Cessna 185 fixed wing aircraft for staging surveys. We conducted two breeding pair surveys to estimate indicated breeding pairs (IBP) for early and late arriving waterbirds. We recorded species, number, gender and social status (e.g., lone male, pair, groups), for all waterfowl, and species and number for other waterbirds seen during the breeding pair surveys. We followed protocol established by U.S. Fish and Wildlife Service and Canadian Wildlife Service (1987), and Black Duck Joint Venture (1996) for determining breeding pair estimates. We conducted three fall staging surveys (late August, mid-September, and early October 1), to estimate relative abundance of migrating/staging waterbirds, including those species listed as locally sensitive by the Committee on the Status of Endangered Wildlife in Canada (e.g., cranes, loons). We recorded species and number of birds seen, and sex when possible. We also recorded incidental observations of wildlife (e.g., moose, caribou, swans, cranes) while flying from one selected wetland basin to another. A detailed description of survey methods is provided by Ducks Unlimited Canada (2003).

Data Analysis.—The objective of the initial phase of the modeling exercise was to synthesize the survey and earth cover datasets into the various predictors and response variables. For this modeling analysis, only the duck data from the 2003-2004 breeding surveys were analyzed, and only the basin data of the earth cover data set were analyzed. This analysis was based on the assumption that terrestrial landforms and earth cover between wetlands is non-habitat, and the earth cover classes within the basin (water, aquatic bed, emergent vegetation) are the primary habitat types that waterfowl are dependent on (Haig et al. 1998). Because collection of data on waterfowl use of other “upland” habitats requires a different sampling method, this assumption allowed the analysis to be focused on the within-basin relationships between waterfowl abundance and wetland basin characteristics.

We used a fuzzy-logic-based analysis (Zadeh 1994) to develop our model to predict waterfowl distributions. First, we developed a membership function for each of the fuzzy sets defined by range groups of waterfowl field measurement data. In this process, we used the lowest, average, highest measurements to create the triangle-like graph for each membership function and adjusted the right side based on the total wetland basin number and the relative
basin size weight of the largest basins within each range group. Secondly, we converted all the
discrete membership functions into a single operable function that could be used for wetland
basin-size-based prediction, called defuzzification. For a given wetland basin size, values derived
from each member function were converted into relative weights first and then multiplied by the
waterfowl measurement expectation of a range group to generate the sub-contribution of a
member function. The observation expectation of a measurement for a given basin was
calculated as the sum of the sub-contribution of all membership functions.

We initially analyzed several predictors (latitude, longitude, elevation, wetland density, basin
area, basin perimeter) for potential use in the model. However, because wetland basin size is a
commonly used landscape factor, with biological and ecological relevance, we used wetland
basin size to build and test our habitat evaluation model. We used non-linear regression models
to determine if there was a significant relationship between wetland basin size and waterfowl
abundance. Once these relationships were established, we created prediction models using fuzzy
logic (Zadeh 1994), an approximate reasoning method.

Given the mobility of waterfowl, the temporal and spatial distributions of wetland basins
across a landscape at local, regional, and landscape level scales are important determinants of
habitat availability. At a local level, a single wetland basin might be able to support a limited
number of waterfowl, but a region of aggregated basins may be functional for a larger number of
birds. This is important for this analysis, because the primary analysis of the modeling was to
examine the relationship between wetland basin size and waterfowl abundance at the basin
landscape level. An analysis of wetland density is thus critical for any determination of habitat
availability. For the Fort Nelson project area, the relative temporal habitat availability was
assumed to be fairly constant, and habitat availability for this project was therefore defined as the
spatial distribution and extent of surface water (water, emergent vegetation, and aquatic bed
earth cover classes).

Habitat availability was determined at varying spatial scales (25-500 pixel distances) using a
circular-shaped moving window focal density. This technique provided a calculation of density
of basin pixels found within the focal area. The focal area was varied from 25 to 500 pixels to
capture local, regional, and landscape level basin densities.
Results

Breeding Pair Surveys.—In 2003, we surveyed 151 randomly selected wetland basins (1,780ha of water) and 153 wetland basins (1,794ha of water) during early and late breeding pair surveys, respectively. Based on our observations, we estimated there were 741 IBP present on surveyed wetland basins during breeding pair surveys. Indicated breeding pairs were recorded for 14 duck species and the 5 most abundant species recorded were: bufflehead (Bucephala albeola) (n = 219), mallard (Anas platyrhynchos) (n = 160), scaup spp. (Aythya spp.) (n = 93), green-winged teal (Anas crecca) (n = 73), and ring-necked duck (Aythya collaris) (n = 65). These 5 species accounted for 64% of all ducks observed. In 2004, we surveyed 153 (123 new wetlands and 30 wetlands surveyed in 2003) randomly selected wetland basins (1,022ha of water). Table 2 shows the number and area of the wetlands surveyed by ecodistrict for the breeding pair surveys. Indicated breeding pairs were recorded for 12 duck species. We estimated that there were 498 IBP present on surveyed wetland basins and the 5 most abundant species recorded were mallard (n = 150), bufflehead (n = 143), blue-winged teal (Anas discors) (n = 56), green-winged teal (n = 30), and scaup spp. (n = 30). Indicated breeding pair estimates on wetland basins surveyed in 2003 and 2004 were similar, 128 IBP and 134 IBP, respectively and are displayed in more detail in Table 3. Also, an average of 20 trumpeter swans (Cygnus buccinator) and 14 common loons (Gavia immer) were seen either on surveyed wetland basins or incidentally in 2003 and 2004.

Table 2. Number and area of wetland basins surveyed for Breeding Pair Surveys I and II conducted on the Fort Nelson Project, British Columbia, 2004. Information for the 30-repeat basins is also provided.

<table>
<thead>
<tr>
<th>Ecodistrict</th>
<th># of Repeat Basins</th>
<th>Area of Repeat Basins (ha)</th>
<th>Total # of Wetlands</th>
<th>Total Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>244</td>
<td>13</td>
<td>64</td>
<td>71</td>
<td>271</td>
</tr>
<tr>
<td>247</td>
<td>2</td>
<td>7</td>
<td>6</td>
<td>25</td>
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<tr>
<td>248</td>
<td>8</td>
<td>23</td>
<td>48</td>
<td>253</td>
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<tr>
<td>249</td>
<td>7</td>
<td>160</td>
<td>23</td>
<td>460</td>
</tr>
<tr>
<td>252</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>30</strong></td>
<td><strong>255</strong></td>
<td><strong>153</strong></td>
<td><strong>1,022</strong></td>
</tr>
</tbody>
</table>

1Surveys were conducted on wetland basins ranging from 1-300ha.

<table>
<thead>
<tr>
<th>Species</th>
<th>Breeding Pairs</th>
<th>IBP/km²</th>
<th>Breeding Pairs</th>
<th>IBP/km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bufflehead</td>
<td>35</td>
<td>13.7</td>
<td>32</td>
<td>12.6</td>
</tr>
<tr>
<td>Mallard</td>
<td>25</td>
<td>9.8</td>
<td>38</td>
<td>15.0</td>
</tr>
<tr>
<td>Scaup spp.</td>
<td>16</td>
<td>6.3</td>
<td>8</td>
<td>3.1</td>
</tr>
<tr>
<td>Green-winged Teal</td>
<td>15</td>
<td>5.9</td>
<td>7</td>
<td>2.7</td>
</tr>
<tr>
<td>American Wigeon</td>
<td>9</td>
<td>3.5</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Ring-necked Duck</td>
<td>9</td>
<td>3.5</td>
<td>13</td>
<td>5.0</td>
</tr>
<tr>
<td>Scoter spp.</td>
<td>9</td>
<td>3.5</td>
<td>10</td>
<td>3.9</td>
</tr>
<tr>
<td>Blue-winged Teal</td>
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<td>2.0</td>
<td>13</td>
<td>5.0</td>
</tr>
<tr>
<td>Northern Shoveler</td>
<td>5</td>
<td>2.0</td>
<td>6.5</td>
<td>2.5</td>
</tr>
<tr>
<td>All other species</td>
<td>0</td>
<td>0.0</td>
<td>6</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Total 128 50.2 134.5 52.8

1Surveys were conducted on wetland basins ranging from 1-300ha. Total area for the 30-repeat wetland basins equaled 255ha or 2.55km².

Staging Surveys.—We observed a variety of ducks, geese, swans, shorebirds, loons, grebes, gulls, and cranes during the fall staging (migration) surveys. In 2003, we surveyed 139 wetland basins (25,021ha of water) during the first survey, and 161 wetland basins (27,190ha of water) on the second and third surveys. During the three surveys periods, we observed 15,101, 11,762 and 11,954 ducks, geese, and swans on wetland basins surveyed. About 33% of all waterbirds seen were observed on Kotcho Lake. In 2004, we surveyed 141, 125, 156 wetland basins during the first, second, and third surveys, respectively. Logistical issues prevented us from surveying the same number of basins for each survey period. Table 4 shows the number and area of the wetlands surveyed by ecodistrict for the staging surveys. We surveyed 25,736, 23,373 and 25,981 hectares of wetland area and observed 15,556, 17,618, 13,695 ducks, geese and swans, respectively. About 43% of all migrating waterbirds observed on randomly surveyed wetlands were seen on Kotcho Lake. Lake Thinahtea in the northeastern corner of the project area, Clarke Lake southeast of Fort Nelson, and Kwokwullie Lake northeast of Kotcho Lake, consistently held numbers close to 1,000 waterbirds per staging survey.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td># of Wetlands</td>
<td>Area of Wetlands (ha)</td>
<td># of Wetlands</td>
</tr>
<tr>
<td>244</td>
<td>52</td>
<td>2,708</td>
<td>60</td>
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<tr>
<td>247</td>
<td>10</td>
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<td>4,498</td>
<td>18</td>
</tr>
<tr>
<td>252</td>
<td>4</td>
<td>90</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>141</strong></td>
<td><strong>25,736</strong></td>
<td><strong>125</strong></td>
</tr>
</tbody>
</table>

1Surveys were conducted on wetland basins ranging from 1-300ha. Total area for the 30-repeat wetland basins equaled 255ha or 2.55km².

Modeling.—Initial regression analysis of all of the predictors showed that the best fit between the waterbird data and wetland basin size ($R^2 = 0.63$), occurred using the square root of the basin size. Thus wetland basin size was selected as an initial test for the model. Using the fuzzy-logic derived approach, we created a model that predicted waterfowl abundance, based on the relationship between wetland basin size and observed waterfowl abundance (Figure 3).

Figure 3. Results of the fuzzy-logic model showing the relationship between wetland basin size and waterfowl abundance on the Fort Nelson project area, 2003-2004.
The overall $R^2$ value for this model was 0.71 ($p=0.001$). Although this model was simplistic in that it only used one factor, the high correlation between wetland basin size and waterfowl abundance allowed for the fuzzy-logic modeling approach to be applied to the data. We used this model to generate expected waterfowl abundance classes for each wetland basin in the project area (Figure 4).

![Figure 4](image)

**Figure 4.** Subset of the predicted waterfowl abundance from the fuzzy-logic model calculated for wetland basins larger than 1ha in the Fort Nelson project area, 2003-2004.

**Discussion**

*Breeding Pair Surveys.*—The difference between the number of IBP from 2003 (741 IBP) and 2004 (498 IBP) can be partially explained by the amount of water surveyed in each year. The number of wetlands surveyed was approximately the same each year, but the total area surveyed in 2003 (1,794ha) was larger than in 2004 (1,022ha). This was primarily because in 2003 we surveyed some wetlands where water chemistry data were collected in 2001 and we wanted to conduct waterbird surveys on these wetlands. At first glance, it appears that IBP densities were higher in 2004 (48.7 IBP/ha), the year in which we observed fewer pairs, than in 2003 (41.3 IBP/ha); however when examining the 30-repeat wetlands, which were surveyed in both years,
there appears to be no difference in IBP densities between 2003 (50.2 IBP/ha) and 2004 (52.8 IBP/ha). Consequently, we believe that the number of breeding ducks in the Fort Nelson project was consistent in 2003 and 2004, although no statistical tests have been conducted to verify this statement.

Staging Surveys.—Based on our observations, Kotcho Lake appears to be a very important annual staging area for a variety of waterbirds. Additionally, smaller wetlands appear to be important for staging waterbirds, thus should not be ignored when considering management options. It is, however, too early for us to draw strong conclusions about habitat and staging waterbird relationships. Consequently, in the future, we plan to examine these relationships in more detail.

Modeling.—The goal of the modeling is to develop a predictive habitat evaluation model using the primary data inputs (2003-2004 survey data, earth cover classification, and elevation) to examine relationships between habitat characteristics and waterfowl abundance, richness, and breeding densities. Other objectives of the model are:

- To have the inherent flexibility to incorporate several different input data sources (earth cover, waterbird surveys, water chemistry, GIS layers), statistics (predictors for habitat use, selection, availability, etc.), and biological information.
- To be able to be integrated into one model that can readily be adapted to different landscape levels (ecodistrict, ecoregion, etc.).
- To be refined based on additional information sources (the additional layer can be added to the analysis without having to redevelop the entire model).
- To allow for weighting and scaling of each individual input dataset.

Further, the ultimate objective of these model outputs is to provide a better understanding of the ecological connectivity among waterbirds and their habitats at different scales so that they can be used for land-use planning purposes.

The overall functionality of the model is highly dependent on the quality of the initial data inputs, and how well the various datasets merge within the confines of the model. For these reasons, a considerable amount of time was spent understanding all aspects of each dataset to optimize the model development. The basic input datasets that were available at the time of the model development exercise included the survey data, the earth cover dataset, and a derived
elevation dataset from the Shuttle Radar Topography Mission (SRTM). Water chemistry data were not available at the time of this analysis, but the data will likely be used in future analyses.

This modeling exercise showed promising results using wetland basin size as a predictor for waterfowl abundance, which allowed for the development of the fuzzy logic-based GIS modeling approach. As more data becomes available for input into the model (water chemistry analysis, surficial geological analysis, 2005 survey results, etc.), the inherent flexibility of the model will allow for additional levels of information (e.g., species richness and breeding densities of waterfowl) to be added.

A preliminary example output of the model is shown in Figure 5, which is a representation of the spatial distribution of waterfowl abundance across the project area. The graphic in Figure 5 shows the relative density of waterfowl abundance with areas of low abundance in red and high abundance in blue. Note at the regional scale, areas with many small to medium-sized wetland basins have the same importance as the very large single wetland basins. These types of outputs can be used by resource managers, researchers, and other data users to identify key habitat areas within the project area.

Figure 5. Preliminary example of how the model output can be used to determine important habitat areas throughout the Fort Nelson project area, 2003-2004.
The predictive model was designed to be flexible, and additional information will be used to refine the model as it becomes available. These models will be used to advance conservation programs in the project area. Conservation programs could include:

- The identification of key wetland systems important to waterfowl and other wetland dependent wildlife that can be set aside as a part of a network of protected areas.
- Partnerships with the forest industry in watershed-based conservation planning that integrate water and wetland conservation objectives into forest management planning and operations.
- Preservation of critical habitat areas through aboriginal partnerships.

**Relevance to applied conservation and improved environmental policy**

Ducks Unlimited in cooperation with our partners plan to develop conservation programs in areas that are identified as having high waterbird values. Understanding the relationship between ecologically connected components such as habitat and waterbird use is necessary to identify such areas. Once all data have been collected, these data will provide a benchmark for evaluating the value and potential of wetlands for waterbirds in the context of the Taiga Plain specifically, and the western boreal ecosystem in general. Furthermore, by applying a change detection analysis (Ducks Unlimited 2003) on historical and future TM satellite images, we will have an opportunity to document landscape changes through time, which may help illustrate the impact of development on the western boreal forest ecosystem. We believe our results will not only be able to identify critical waterbird habitat, but also that this information can be used at changing overall environmental policies, and resource extraction methods in the western boreal forest, which should have a positive influence on numerous species relying on the threatened ecosystem. Furthermore, and most importantly, our model is intended to select sensitive areas using zoning properties, which will hopefully lead to more efficient land-use planning, and ultimately an increased amount of interconnected protected areas.

**Future Plans**

In 2005, we plan to complete the final-year of aerial surveys for the 3-year Waterbird Inventory Project for the Fort Nelson area. Two breeding pair and three staging waterbird
surveys will be conducted. A comprehensive final Fort Nelson Waterbird Survey report will be available to partners in 2007.

**Acknowledgments**

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