PRELIMINARY ANALYSIS OF REPRESENTATIVE CORE AREAS

for the

NORTHWEST TERRITORIES
PROTECTED AREAS STRATEGY

Addendum
To the
Appendices

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1. EXPANDED METHODS FOR HUMAN USE INTENSITY ANALYSIS AND FOOTPRINT

To create a human use footprint, the area of buffered features was summarized by planning unit and overlapping areas were merged. In this way, bias towards areas and/or features that were mapped at greater density due to mapping effort was reduced to some degree.

Buffers

a) Major Impacts: Buffer by 1000m

Major impacts were defined as those human uses and activities that are characterized by continuous or high intensity human presence or human activity across the landscape. These features were buffered by 1000m – a number taken from the scientific literature as a relatively conservative 'zone of influence' – where indirect and direct human intervention influences biodiversity patterns or processes (Forman 1995; Forman and Deblinger 2000).

Features that were classified as Major Impacts included:

- Towns
- Major roads (year-round)
- Winter Roads
- Outfitter lodges & camps
- Mineral Production: producer

b) Moderate / Low Impacts: Buffer by 250m

Moderate or low human impacts were defined as those areas with more infrequent human presence and/or moderate to low human activity intensity. Note that it would be better to have explicit intensity attributes for each of these features (e.g. tons of materials extracted for mines, road traffic, Oil production in barrels etc.), but such data were unavailable at the time of the study. Nevertheless, we suggest that these activities, on average across the study area, reflect relatively lower intensity human uses than those classified as "Major Impacts". A buffer width of 250 meters was selected based on ecological literature describing both the direct and indirect zone of influence (Forman 1995; Forman and Deblinger 2000). Note that buffer width is likely to vary according to intensity and also for different features – we suggest that additional expert opinion be gathered to address these, and similar other, issues. Moderate / Low human uses included:

- Mineral Production: abandoned
- Mineral Production: care and maintenance
- Mineral Production: minor/renewed exploration
- Mineral Production: drilled

- Existing and proposed pipelines and pipeline facilities
- Trails, seismic lines & cutlines
- Historic Oil and Gas wells

Summarization of Footprint

Buffered areas for each data set were dissolved to create a single human use surface such that overlapping uses were not additive. Each planning unit was then scored according to the total hectares of human use footprint within the unit.

2. CONVERTING THE HUMAN USE INDEX TO A MARXAN COST LAYER

A simple human use intensity map was designed specifically for use within the site-selection software used by this study (see Section 6). This map represents a continuous surface of values for the study area that is utilized in analysis to guide conservation areas towards relatively intact areas. Areas of low human use are designated as being less costly for the site selection model, and therefore are preferentially incorporated by the software for meeting representation goals. Areas of high human use have a high cost for the model, and are thus avoided where possible.

Weightings for MARXAN were established for each planning unit using the total hectares of human footprint within the unit as a raw score. Since there was some variation in the size of planning units, these raw scores were normalized to a score between 1 and 2001 (the majority of planning units had a base size of 2000 ha; a zero score is incompatible with MARXAN parameters, thus the lowest score is set at 1). Normalization was done applying the following formula,

Planning Units (pu) cost =
(total human use score for pu / maximum pu human use score found in study area) x 2000

3. EXPANDED METHODS FOR DEVELOPMENT INTEREST INDEX

Summarization Methods

Data for each general 3rd party interest category were grouped (see table 3.1 for categories and data used). Standard z-scores (n - mean(N) / standard deviation(N), where n is a planning unit summary measure and N is overall population distribution) of physical measurements (e.g. number of points, km of line features) were calculated to produce sub-index values of similar scale. A single development interest index was calculated for each planning unit as the natural log of the mean sub-index for each category +1 scaled to be between 0 and 100. These transformations reduced variance in the data and resulted in a more uniform distribution of values that reflected relative intensity of 3rd party interests.

Table 3.1 Summary of data and attributes used for Development Interest Index

Category	Attribute	Type	Measure	Sub-index
Mining				
	Mine_drilled	Point	# per pu	z-transformed (subtract mean, divide by std)
	Mine_abandoned	Point	# per pu	z-transformed
	Mine_renewed	Point	# per pu	z-transformed
	Claim	Boolean	mining claim (y or n)*	z-transformed
Oil and Gas				
	Pipeline - proposed	Line	km per pu	z-transformed
	Pipeline	Polygon**	ha per pu	z-transformed
	Pipeline – proposed facilities (point)	Point	# per pu	z-transformed
	Seismic Line	Line	km per pu	z-transformed
	Oil and Gas claim	Boolean	Oil and Gas claim (y or n)*	z-transformed
Category	**Attribute**	**Type**	**Measure**	**Sub-index**
Road				
	All-season	Line	km per pu	z-transformed
	Winter	Line	km per pu	z-transformed
Towns				
	Presence	Buffered point	ha within 1km	z-transformed
Human Presence				
	Lodges and Camps	Buffered point	ha within 250m	z-transformed
	Trails	Line	km trails	z-transformed
Development Interest Index				
				mean for each category
				log transformation
				scale between 0 - 100

*The large expanse that these claims cover, relative to the size of planning units, means that essentially, most planning units are either 100% within the claim, or 100% outside. Only the relatively few planning units along the border of these claims have any variation is area, and as such planning unit attribution was simplified to the binary yes/no.

**Data for the proposed pipeline route included two overlapping line files. These were simply summarized by creating a single buffered polygon that contained both lines.

4. EXPANDED METHODS FOR SPECIAL ELEMENTS INDEX

We created a Special Elements Index (SEI) as a measure of the relative abundance of each special element for each planning unit in the study, by dividing special element abundance (i.e. hectares or number of point occurrences) by overall abundance.

$$SEI_{pu} = se_{pu} / se_{total}$$

where:

pu = planning unit

se = abundance (hectares or number of point occurrences) of special element in planning unit

This approach takes into account the quantity of data available, and measures abundance for each feature or element, relative to the amount described by the available data set (e.g. if a data set has 10 occurrences of an element in it, and a planning unit has 1 of those, that planning unit holds 10% of the available data for the element or feature. In this way, elements that simply have more data collected for them are not favoured over elements with fewer data points. Using this approach we created what is sometimes referred to as a 'Hotspot' map (Map [10]).

We grouped the special elements data into five categories (Table 3.1 for details):

- Birds
- Non-Caribou mammals
- Caribou
- Areas designated in multi-purpose land use prioritization or planning excercises
- Rare plants

For each category a separate, area normalized, SEI was calculated as follows:

$$SEI_c = \sum_{i=i}^{n} [se_i / se_{total}] / aI$$

where:

n = number of different special elements in category

se = abundance (hectares or number of point occurrences) of special element in planning unit

aI = planning unit area / total study area

Finally, a single combined SEI was assigned to each planning unit, as the mean of SEI for all five categories. This approach had the utility of weighting each category equally, and reduced bias from differential mapping effort. Note that for kernel estimates (used for Caribou herd habitat), 50% and 99% kernels were both used. Although these were not weighted in the index (i.e. the 99% kernels were not counted as being "more" habitat than the 50% kernels), they represent concentric polygons of habitat and the 99% kernels essentially were weighted by a factor of 2, since the habitat area they encompass was counted twice – once using the 99% kernel layer, and then again using the 50% layer. All data were treated as area features except for rare plant locations which were treated by number of occurrences. No special element features were buffered by this analysis team, though we are aware that raptor sites had been buffered by the data supplier.

Table 4.1 Special Features data used for representation analysis and 'hotspot' analysis. Categories are used for summarizing representation of elements.

SE Catalogue Code	SE Feature	Category
Crithab_curlew	Critical Habitat –Curlew	bird
Crithab_raptor	Critical Habitat – Raptor	bird
Crithab_watrfwl	Critical Habitat – waterfowl	bird
Crithab_whpcrane	Critical Habitat -Whooping crane	bird
Iba	Important Bird Areas	bird
Key_migrbird_hab	Key Migratory Bird Terrestrial Habitat	bird
Raptor	Raptor Nest Sites Buffered	bird
Waosi_nesting	Wildlife Areas of Special Interest – Nesting	bird
Bluenose_east50	Bluenose Caribou Herd East 50% kernel	caribou
Bluenose_east99	Bluenose Caribou Herd East 99% kernel	caribou
Bluenose_west50	Bluenose Caribou Herd West 50% kernel	caribou
Bluenose_west99	Bluenose Caribou Herd West 99% kernel	Caribou
Cape_bathurst50	Cape Bathhurst Herd 50% kernel	Caribou
Cape_bathurst99	Cape Bathhurst Herd 99% kernel	Caribou
Caribou_all	Critical Habitat - Caribou all	Caribou
Caribou_calving	Critical Habitat - Caribou Calving	Caribou
Caribou_migr	Critical Habitat - Caribou Migration	Caribou
Caribou_minrl	Critical Habitat - Caribou Mineral Licks	Caribou
Caribou_winter	Critical Habitat - Caribou Winter	Caribou
Dehcho_bwc_hi	Dehcho Boreal Woodland Caribou, high quality habitat winter	Caribou
Gwichin_bwcwin_hi	Gwichin – Boreal Woodland Caribou winter hi habitat	Caribou
Crithab_grizz	Critical Habitat - Grizzly Bear	Mammal
Crithab_othrmamm	Critical Habitat - other mammal	Mammal
Crithab_polrbear	Critical Habitat -Polar Bear	Mammal
Sheepgoat_calv	Sheep / Goal Calving Habitat	Mammal
Sheepgoat_minrl	Sheep / Goat Mineral Licks	Mammal
Sheepgoat_river	Sheep / Goat River Crossings	Mammal
Sheepgoat_winter	Sheep / goat Winter Habitat	Mammal
Waosi_calving	Wildlife Areas of Special Interest - Calving	Mammal
Waosi_concentr	Wildlife Areas of Special Interest - Concentrations	Mammal
Waosi_denning	Wildlife Areas of Special Interest - Denning	Mammal
Waosi_feeding	Wildlife Areas of Special Interest - Feeding	Mammal
Waosi_refuge	Wildlife Areas of Special Interest - Refugia	Mammal
Waosi_wintering	Wildlife Areas of Special Interest - Wintering	Mammal
Ibp_sites	International Biological Programme Sites	multi-purpose
Mbc_sensitive	Mackenzie Basin Committee sensitive sites	multi-purpose
Rare_plant	Rare Plant point locations	plant

5. EXPANDED METHODS FOR CONSERVATION VALUE INDEX AND CONSERVATION PRIORITY

Conservation Value

Frequency of Selection by Representation Analysis

For comparative purposes we described conservation value using two separate measures, both drawn from Marxan representation analysis. The first measure, typically called the "best" solution, defines the most efficient (minimum) set of analysis units that meet the pre-determined target representation goals, while also minimizing the additional cost associated with a spatially fragmented solution. Each run of the Marxan model generates a "best" solution. Marxan is typically parameterized such that each time the software is run, many independent model runs are executed. The *overall* "best run" represents the single most efficient solution found out of all of the independent model runs (in this case 100).

The second measure, often called the "summed solution", describes the number of times any given planning unit was selected as a member of a "best" solution, across all 100 *independent* model runs. As such, any given planning unit may receive a value from 1 to 100, depending on how many times it belonged to a "best" solution across all of the model runs. This can lead to non-intuitive results, as it is easy to assume that all high value planning units from the "summed solution" should be included in the "best solution" out of the 100 runs. The difference here is that the "summed solution" measure combines the "best run" data *across all* model runs, whereas the overall "best run" measure selects the *single* most efficient model result out of all the model runs that were executed. If we were to allow each individual Marxan run to continue running with many more iterations (something that is not always possible given real-world computing constraints), we would see that the correspondence between the high "summed solution" value planning units and the "best run" planning units would converge.

Planning Unit Conservation Value Score = planning unit MARXAN "summed run" score*

*The summed run score is an output of MARXAN found in the scenario_name_ssoln.text output table. Column heading is called "number".

Combined Conservation Value Score

Both the conservation value score from representation analysis and Special Elements Index were summarized to create a third, combined measure of conservation value (Map 10a). Both the conservation values score and the SEI for each planning unit were normalized to a score out of one. The combined conservation value score was then calculated by summing the two normalized scores and dividing by 2 to get a mean value for each planning unit.

Conservation Priority

Final scores around conservation priority (see section 7.2) were based upon comparing conservation value scores with threat information. For this process the study area was split evenly into a “high” conservation value area and a “low” value area, based on an equal area weighting (with 2 classes) of ‘combined conservation value’ scores for each planning unit. Next, the development interest index was split into 4 quantiles from lowest (1) to highest (4) interest. The highest value conservation areas (the half of pu’s with highest combined conservation value) were then mapped and graded from 1 to 4 based on the threat quantile they fell into.

6. MARXAN PARAMETERS FOR COMPARATIVE SCENARIO EXPERIMENTS

Scenario	Boundary Modifier	Repeat Runs	Heuristic	Iterations	Temperature Decreases	Cost Threshold	Starting Prop
Minimum area goals	0.01	10	Greedy	N/A	N/A	Not Used	N/A
BG Open	0.05	100	Simulated Annealing	1,000,000	10,000	Not Used	0
BG Closed	0.05	100	Simulated Annealing	1,000,000	10,000	Not Used	0
PG Open	0.05	100	Simulated Annealing	1,000,000	10,000	Not Used	0
PG Closed	0.05	100	Simulated Annealing	1,000,000	10,000	Not Used	0

BG = Baseline Goals
PG = Precautionary Goals
Open = Existing and proposed protected areas not locked in
Closed = Existing and proposed protected areas locked in
Please refer to Section 6.2 of Volume 1, Final Report.