Appendix 2. Statistical models to estimate footprint of seismic lines and pipelines for jurisdictions in the Western Canadian Sedimentary Basin lacking geo-referenced data.

SUPPLEMENTAL METHODS

Data from Alberta Sustainable Resource Development (Appendix 1) were summarized using GIS to calculate density of wells (wells/km^2) and area disturbed (as proportion of township) by seismic lines and pipelines respectively within townships across Alberta. General linear modeling (GLM) was subsequently used to model proportion of a township disturbed by seismic lines and pipelines as a function of well densities. Prior to analysis, well densities (hereafter log(wells)) were transformed using $\log_{10}(x+0.5)$ to meet the assumptions for GLM. Similarly, both the proportion of a township disturbed by seismic lines and the proportion of a township disturbed by pipelines were square root transformed prior to analysis. For both response variables, three competing models models were considered; i.e. log(wells), log(wells) + Natural Region, and log(wells) + Natural Region + log(wells)* Natural Region. The model with the lowest AIC (Akaike's Information Criterion) score was subsequently selected as the most parsimonious model (Burnham and Anderson 1998).

RESULTS

Data from 7115 townships in Alberta were summarized. Well densities averaged 0.53 wells/km^2 (median = 0.22, range = 0 – 10.36). An average of 0.76% of township area was disturbed by seismic lines (median = 0.48, range = 0 – 12.08). Pipeline right-of-ways made up an average of 0.59% of township area (median = 0.25, range = 0 – 8.68).

The most parsimonious model for proportion of townships disturbed by seismic lines included log(wells), Natural Region and the interaction between Natural Region and log(wells) and was separated from the next best model by over 298 AIC units. The top model explained ~31% of the variance in proportion of townships disturbed by seismic lines. Based on the parameter estimates (Table A.2.1), the derived equation for estimating the proportion of township disturbed by seismic lines in the Boreal Plain ecozone can be estimated as:

$$\% \text{ of township disturbed by seismic} = (0.974 + 0.807*\log(\text{wells}))^2 \quad (1)$$

The parameter estimates suggest that given an equal density of wells, the area disturbed by seismic lines is lower in the Grassland Natural Region than the Boreal ecozone (Table A2.1). The proportion of a township disturbed by seismic lines in the Grassland Natural Region can be estimated as:

$$\% \text{ of township disturbed by seismic} = (0.430 + 0.006*\log(\text{wells}))^2 \quad (2)$$

The most parsimonious model for the proportion of townships disturbed by pipeline right-of-ways also included log(wells), Natural Region and the interaction between Natural Region and log(wells). The top model was separated from the next best model by over 798 AIC units, and explained ~63% of the variance in proportion of townships disturbed by pipeline right-of-ways. Based on the parameter estimates (Table A2.2), the proportion of a township disturbed by pipeline right-of-ways in the Boreal Plain ecozone can be estimated as:

$$\% \text{ of township disturbed by pipeline} = (0.699 + 1.866*\log(\text{wells}))^2 \quad (3)$$

Similar to the analysis for seismic lines, the parameter estimates suggest that given equivalent well densities, the area disturbed by pipeline right-of-ways is higher in the Boreal ecozone than the Grassland Natural Region (Table A2.2). Using parameter estimates reported in Table 2, the proportion of a township disturbed by pipeline right-of-ways in the Grassland Natural Region can be estimated as:

$$\% \text{ of township disturbed by pipeline} = (0.655 + 1.811*\log(\text{wells}))^2 \quad (4)$$

Table A.2.1. Parameter estimates for predicting proportion of townships disturbed by seismic lines. Note: the predictions must by squared due to square root transformation of the response variable prior to analysis.

Parameter	β	SE	t- value	P
Intercept	0.947	0.008	125.438	<0.001
log(Wells)	0.807	0.032	25.282	<0.001
Foothills	0.201	0.017	12.076	<0.001
Grassland	-0.517	0.016	-32.602	<0.001
Parkland	-0.475	0.020	-23.872	<0.001
Rocky Mountain	0.243	0.089	2.730	<0.001
log(Wells):Foothills	-0.371	0.085	-4.352	<0.001
log(Wells):Grassland	-0.801	0.054	-14.730	<0.001
log(Wells):Parkland	-0.701	0.076	-9.206	<0.001
log(Wells):Rocky Mountain	2.131	0.312	6.840	<0.001

Table A2.2. Parameter estimates for predicting proportion of townships disturbed by pipeline right-of-ways. Note: the predictions must by squared due to square root transformation of the response variable prior to analysis.

Parameter	β	SE	t- value	P
Intercept	0.699	0.006	109.097	<0.001
log(Wells)	1.866	0.027	68.918	<0.001
Foothills	0.208	0.014	14.681	<0.001
Grassland	-0.044	0.013	-3.275	<0.05
Parkland	-0.046	0.017	-2.734	<0.05
Rocky Mountain	0.405	0.076	5.370	<0.001
log(Wells):Foothills	0.459	0.072	6.336	<0.001
log(Wells):Grassland	-0.055	0.046	-1.200	0.230
log(Wells):Parkland	-1.689	0.065	-26.128	<0.001
log(Wells):Rocky Mountain	1.644	0.264	6.218	<0.001

LITERATURE CITED

Burnham, K.P., and D. R. Anderson. 1998. *Model Selection and Inference: A Practical Information-Theoretic Approach*. Springer-Verlag, New York, NY, USA, 353 pp.