

Forecasting the Impact of Land-use Change on Boreal Caribou

Christina A.D. Semeniuk^{1,2}, David Birkigt¹, Marco Musiani¹, Greg. J. McDermid¹, Mark Hebblewhite³, Scott Grindal⁴, and Danielle J. Marceau¹

¹University of Calgary, Alberta, ²GLIER, University of Windsor, Ontario, ³University of Montana, Montana, ⁴ConocoPhillips Canada, Calgary, Alberta
semeniuc@ucalgary.ca

Introduction: Predictive models based on animal behavioural decisions in a spatially explicit context can lead to unexpected but critical findings for wildlife management. A combination of approaches is required to evaluate the **cumulative impacts of multiple stressors** associated with planned human development. Our research uses a hybrid model that combines computational intelligence (agent-based model, ABM) and geocomputation (cellular automata, CA), with geographic information systems (GIS) for simulating the processes that drive boreal caribou habitat selection and their responsiveness to anthropogenic features – oil and gas and forestry – in alternative future landscapes.

Methods: The **ABM** model establishes a behavioural & bio-energetic baseline of caribou responses. It is composed of cognitive caribou agents that use habitat-selection strategies based on energetic needs and risk-minimization to navigate the landscape. The **CA** simulates future wellsite location and number, based on historical patterns. Development constraints are built into the spatial model to represent different plausible futures in 2020. Spatial harvest sequences for 2020 were supplied by the AB Government. **Caribou ABM + Spatial CA** explores how changes in landscape development affect: caribou habitat, habitat use, and caribou fitness.

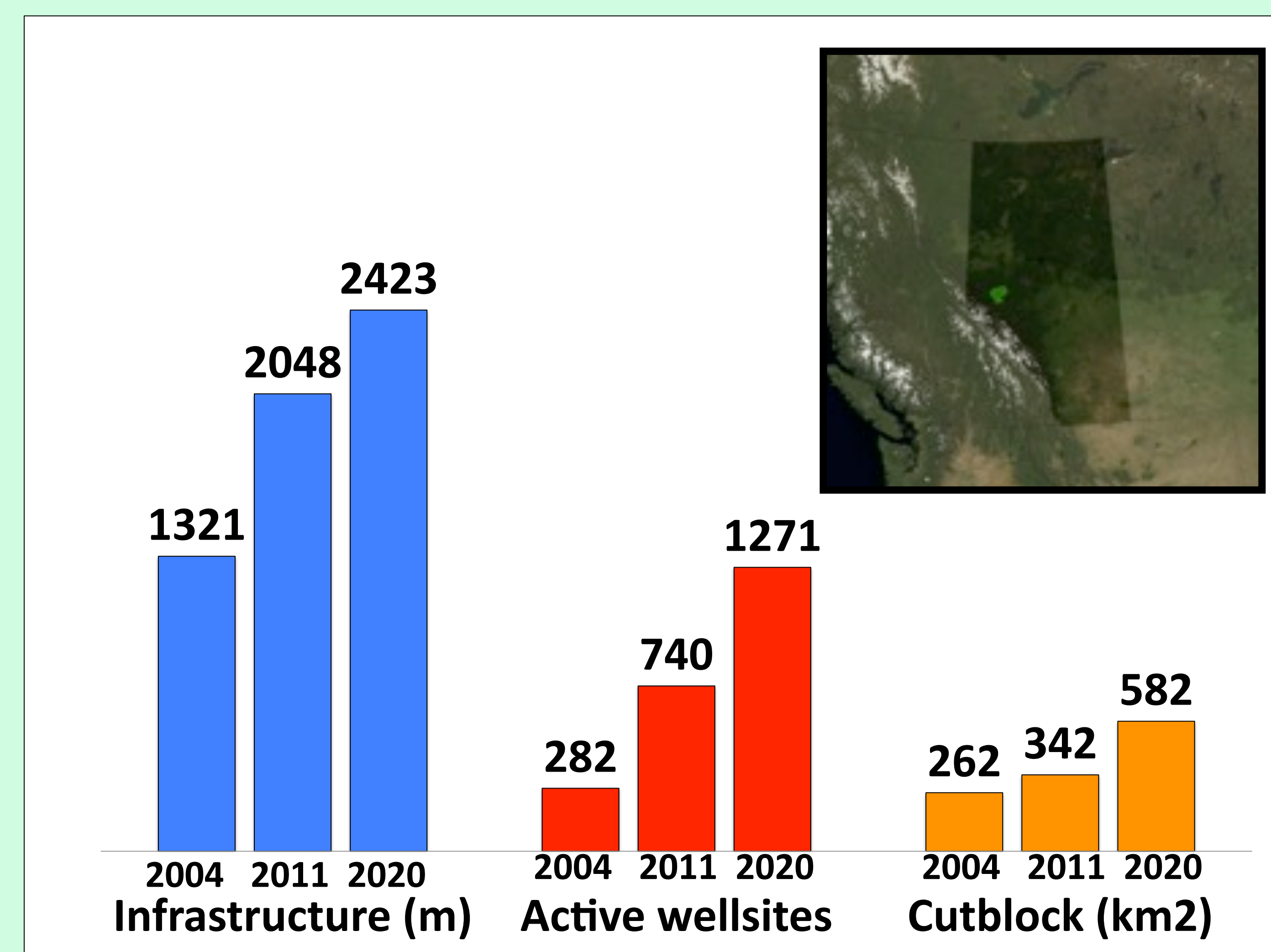


Fig. 1 Actual and predicted industrial development in the Little Smoky caribou range, AB.

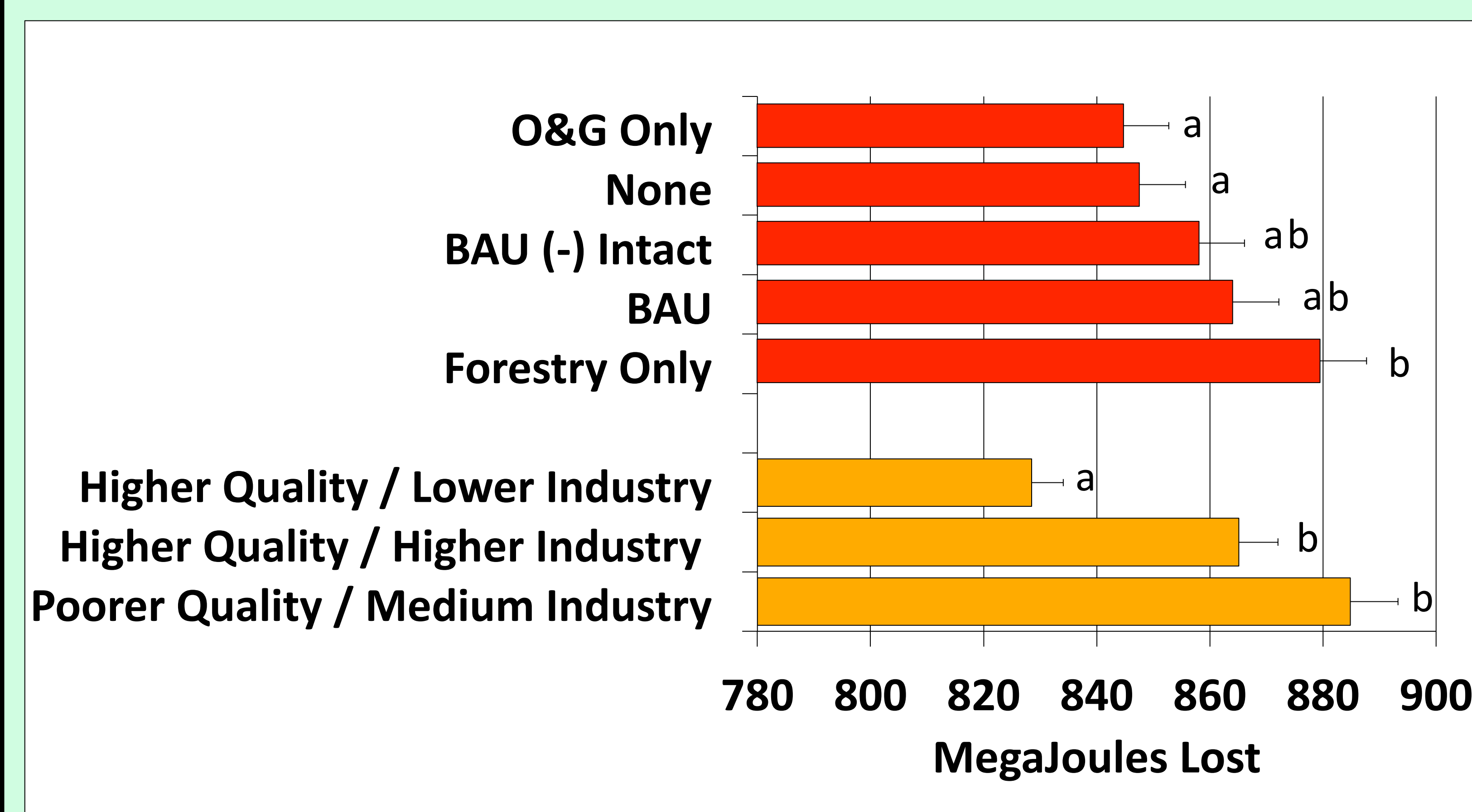


Fig. 3 Cumulative energetic loss by agents over the winter in different future scenarios, and in different habitat types.

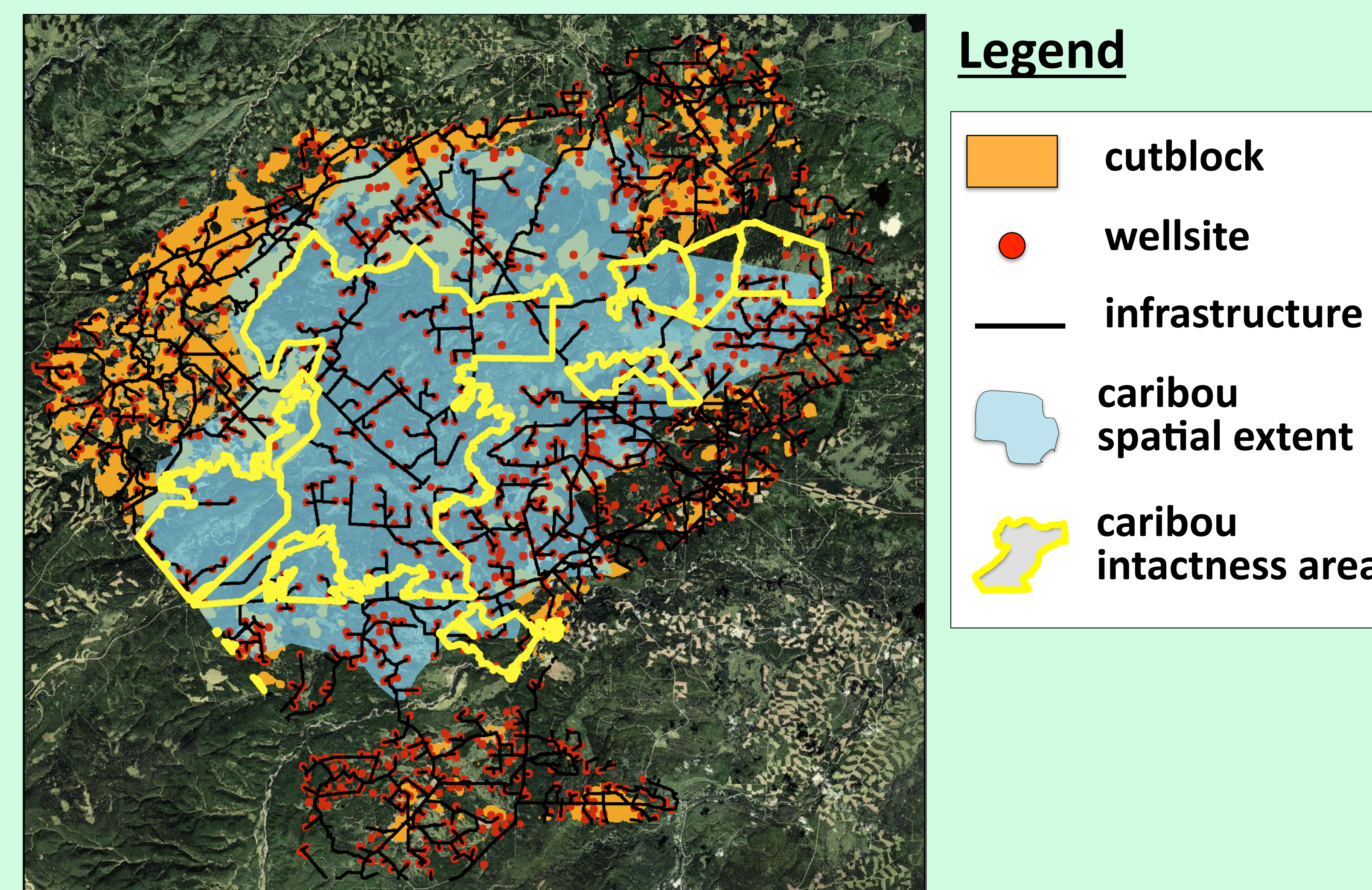


Fig. 2 Predicted spatial distribution in 'Business As Usual 2020', with excluded future development in intactness area.

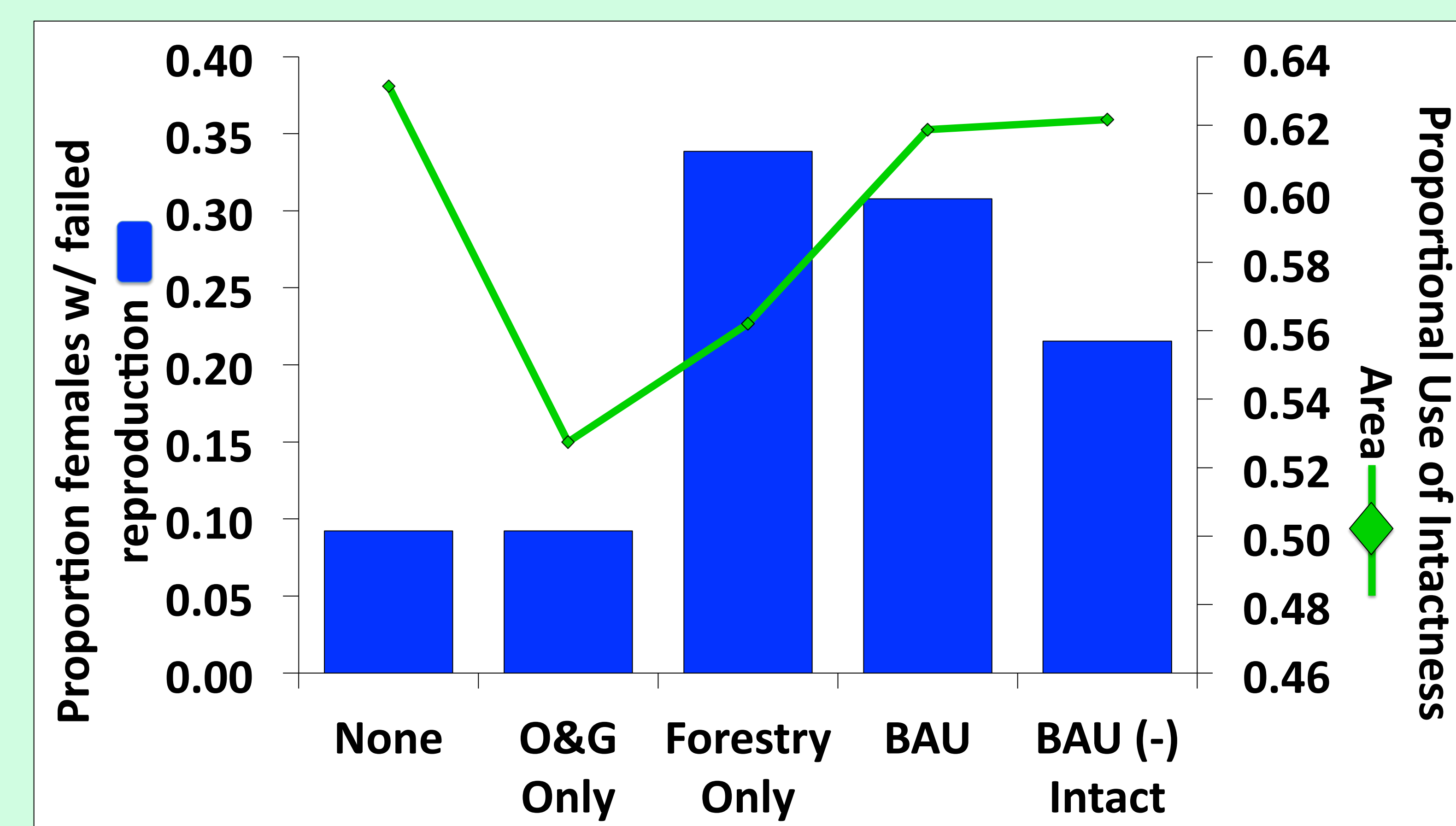


Fig. 4 Proportion of females with failed reproduction (mass loss > 20%) in comparison to use of intactness area.

Results & Discussion: (1)

Herd spatial extent progressively contracted with increasing industry intensity. **(2)** Controlling for daily-movement effects and individual home range, caribou agents lost most reproductive energy when forestry was developed to 2020 levels, and when agents frequently encountered industrial features. **(3)** Despite increased use of intactness area, females reproductively failed if oil and gas continued to develop within.

- Critical-habitat inferences from wildlife spatial distributions alone can be inadequate.*

Process-driven, spatial models in predictive ecology are necessary.

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