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A multi-objective metaheuristic approach to beetle-killed biomass supply chain management in the northern Colorado Rocky Mountains

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Abstract

Mountain pine beetle-caused tree mortality is a significant forest management challenge in the Rocky Mountain region. Although infested forests represent a vast biomass resource that may be environmentally beneficial, utilization of beetle-killed biomass has been constrained due to relatively low product value and high costs of harvesting and transportation. This economic challenge becomes more pressing over time as beetle-killed stands degrade and salvage harvesting costs increase. Sound supply chain planning is needed to make timely and efficient use of these resources from both economic and environmental perspectives. In this study, we develop a multi-objective metaheuristic called Multi-objective Record-to-Record Travel (MRRT) to solve supply chain planning problems for beetle-killed biomass while integrating net present values and net reduction in greenhouse gas (GHG) emissions. We applied this optimization approach to Colorado State Forest located in the northern Colorado Rocky Mountains. The resulting Pareto front exhibits the trade-offs between economic and environmental objectives. Scenario analyses are conducted to investigate the effects of forest degradation rates and recoverable biomass on the efficiency of biomass supply chain.

Key words: Multi-objective optimization, metaheuristics, beetle-killed biomass, salvage harvesting, GHG