Description of the OpCost forest operations cost simulator

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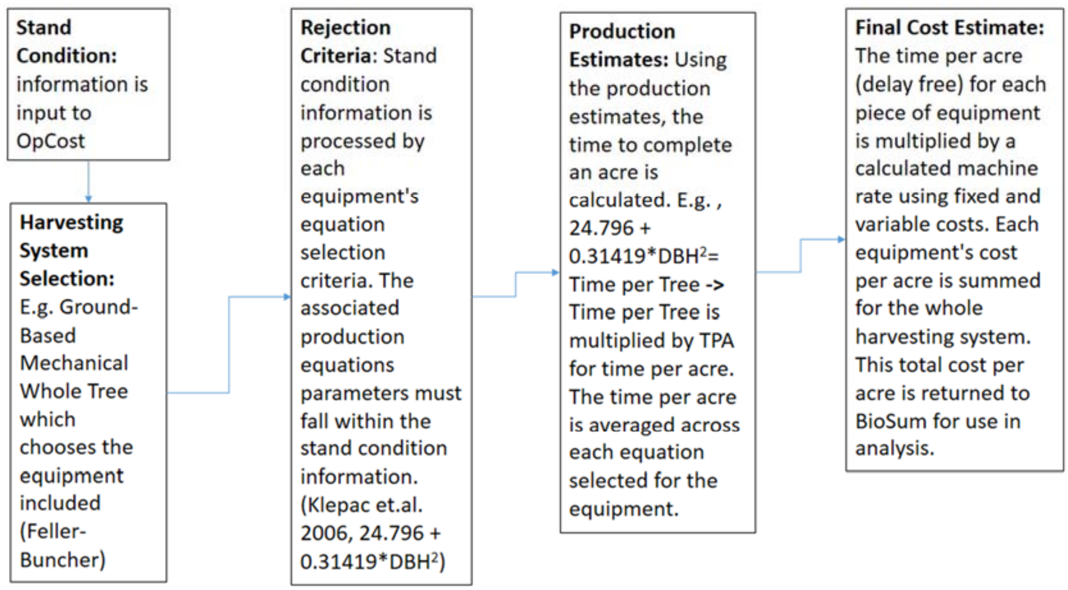
OpCost is a flexible forest operations cost model. OpCost incorporates production rates from recent studies of both manual and mechanized operational systems. The standalone R interpreter version is tightly integrated with BioSum to estimate the costs for modeled forest harvest operations. OpCost is driven by input variables similar to those used with the Fuels Reduction Cost Simulator (FRCS; Fight, Hartsough, & Noordijk, 2006). For harvested trees, 21 variables account for average volume per tree, number of trees harvested per acre, hardwood fraction and residue fraction for each of three tree size classes. OpCost also accounts for the cost of cutting very small trees that are cut but not utilized along with slope and average distance to the nearest landing.

The integration of OpCost with BioSum produces cost estimates for applying each analyst specified combination of silvicultural prescription and harvest system on each inventory plot modeled in BioSum, facilitating estimation of cost-effectiveness of a wide range of fuel treatments on managed forests in the West. As a callable code package with the R interpreter, OpCost streamlined workflow relative to FRCS by eliminating the need to export data to Microsoft Excel as an intermediate step prior to FRCS calculations. Instead, BioSum passes OpCost inputs and receives OpCost outputs via tables in an MS Access database.

One OpCost enhancement is the simultaneous estimation of cost for multiple, potentially more cost efficient harvest systems. These estimates can be compared against the costs of the analyst specified harvest system, and could ultimately replace the analyst specification, if desired.

OpCost builds on the core architecture developed for FRCS, adding production functions developed since the last release of FRCS in 2009,and provides treatment cost estimates based on conventional cost control processes (Matthews, 1942). Fixed and variable costs are simulated for each machine or process in a given harvesting or thinning operation (Dodson, Hayes, Meek, & Keyes, 2015). The estimated production rates for machines are generated from empirical equations documented in peer-reviewed literature and based primarily on elemental time analysis studies. Production functions in OpCost use the estimated amount of removed or altered material within forest stands and the silvicultural prescriptions passed from BioSum. These are used to forecast the time and expense required to harvest and process wood volume on a per-acre basis.

Figure 1: Example the cost estimation process.



In BioSum simulations, OpCost represents a large number of harvesting and processing equipment options being deployed in a range of silvicultural systems in order to simulate cost estimates in ways that make sense. In order to handle that wide variety of systems the model is designed to be adaptable. Production rates for new kinds of equipment can be implemented by entering the parameter and predictor variables associated with the production rate for the new equipment into a pre-formatted Excel table. The production function supplied should include output in total treatment time (delay-free Productive Machine Hours), expressed on a per-acre basis. Users should also supply the key components of equipment machine rates: purchase price, utilization rate, etc. Please see, e.g., Brinker, Kinard, Rummer, & Lanford, 2002 for a description of machine rate calculations. The user-supplied production function parameters and machine rates are incorporated into system-level logging cost predictions.

Table 1: List of referenced production rate documents.

OpCost

Production Equations
Manual Saw (Behjou & Majnounian, 2009), (Klepac, Rummer, & Thompson, 2011), (Ghaffariyan, Naghdi, Ghajar, & Nikooy, 2012), (B. R. Hartsough & Xiaoshan, 2001), (Kluender & Stokes, 1996), (Visser & Spinelli, 2012), (Jingxin Wang, Long, & McNeel, 2004), (Lortz, Kluender, & McCoy, 1997)
Harvester (Adebayo, Adebola B.Han-Sup HanJohnson, 2007), (M. C. Bolding, Lanford, & Hall, 2002), (P Hiesl & Benjamin, 2012), (Kärhä, Rönkkö, & Gumse, 2004), (Klepac, Rummer, & Thompson, 2006), (Drews, Hartsough, Doyal, & Kellogg, 2001), (Jiroušek, Klvač, & Skoupý, 2007), (Klepac et al., 2011), (Acuna & Kellogg, 2013), (Akay, Erdas, & Sessions, 2004), (Berhongaray, El Kasmioui, & Ceulemans, 2013), (Numinen, Korpunen, & Uusitalo, 2006), (Eliasson, 1999), (Keegan III, Niccolucci, Fiedler, Jones, & Regel, 2002), (Sirén & Aaltio, 2003), (Visser & Spinelli, 2012)
Skidder (P Hiesl & Benjamin, 2012), (Ghaffariyan et al., 2012), (Kluender & Stokes, 1996), (M. C. Bolding et al., 2002), (Jingxin Wang et al., 2004), (Adebayo, Adebola B.Han-Sup HanJohnson, 2007), (Akay et al., 2004), (Keegan III et al., 2002), (Klepac et al., 2011)
Feller-buncher (B. R. Hartsough, Zhang, & Fight, 2001), (Kluender & Stokes, 1996), (B. R. Hartsough, Drews, McNeel, Durston, & Stokes, 1997), (B. R. Hartsough et al., 1997), (Dykstra, 1976),

(M. C. Bolding & Lanford, 2001), (Kärhä et al., 2004), (Patrick Hiesl, 2013), (Adebayo, Adebola B.Han-Sup HanJohnson, 2007), (Acuna & Kellogg, 2013), (R Spinelli, Cuchet, & Roux, 2007)
Helicopter (Flatten, 1991), (Dykstra, 1976), (Christian & Brackley, 2007), (Flatten, 1991)
Forwarder (Jiroušek et al., 2007), (M. Bolding, 2002), (Kluender & Stokes, 1996), (Sirén & Aaltio, 2003), (Dykstra, 1976), (Drews et al., 2001), (Akay et al., 2004), (Numinen et al., 2006), (Sirén & Aaltio, 2003)
Cable (Service & Ledoux, n.d.), (Aubuchon, 1982), (Dykstra, 1976), (Boswell, 2001), (LeDoux, 1987), (B. R. Hartsough et al., 2001), (B. R. Hartsough & Xiaoshan, 2001), (Keegan III et al., 2002)
Chipper (Raffaele Spinelli & Magagnotti, 2014), (M. Bolding, 2002), (Berhongaray et al., 2013), (Drews et al., 2001)
Shovel (Sessions & Boston, 2013), (J Wang & Haarlaa, 2002), (Fisher, 1986)

Processor (B. Hartsough et al., 2006), (Ghaffariyan et al., 2012), (Raffaele Spinelli & Magagnotti, 2010), (Acuna & Kellogg, 2013), (Visser & Spinelli, 2012)
Loader (Akay et al., 2004), (Numinen et al., 2006), (Drews et al., 2001), (MacDonald, 1990)

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