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Accurate estimation of mean fire interval for managing fire

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Equivalence of two methods for calculating mean individual-tree fire-interval

As proposed by Baker and Ehle (2001), the individual-tree fire-interval method calculates stand mean fire interval in the following manner: 'the mean fire interval of each sample tree is first calculated, then these individual-tree mean fire intervals are averaged among all sample trees, weighted by the number of intervals used to estimate individual-tree fire-interval, to obtain the stand mean fire interval'. The mean fire interval of each sample tree is calculated by:

$$FI_i = (EA_i – SA_i)/IN_i \,, \quad (1)$$

where FI_i is the mean fire interval of tree i, EA_i is the age of the last scar on tree i, SA_i is the age of the first scar on tree i, and IN_i is the total number of fire intervals on tree i between ages EA_i and SA_i . Stand mean fire interval, using the individual-tree fire-interval (*ITFI*) method, is calculated by:

$$ITFI = \frac{\sum_{i=1}^{M}(FI_i / IN_i)}{\sum_{i=1}^{M} IN_i} = \frac{\sum_{i=1}^{M}(EA_i - SA_i)}{\sum_{i=1}^{M} IN_i} \,, \quad (2)$$

where M is the number of sampled trees. We know that:

$$IN_i = SN_i – 1, \text{ and } EA_i – SA_i = TA_i – \Delta OS_i – \Delta ETA_i \,, \quad (3)$$

where SN_i is the total number of scars on tree i, ΔOS_i is the number of years from tree origin to the first scar, and ΔETA_i is the number of years from the last scar to the year of sampling.

By applying the above two equations, we get:

$$ITFI = \frac{\sum_{i=1}^{M}(TA_i - \Delta OS_i - \Delta ETA_i)}{\sum_{i=1}^{M}(SN_i - 1)} = \frac{\sum_{i=1}^{M} TA_i - \sum_{i=1}^{M} \Delta OS_i - \sum_{i=1}^{M} \Delta ETA_i}{\sum_{i=1}^{M} SN_i - M} \quad (4)$$

If we assume that the *ΔOS* interval on average is about half the ITFI, since trees can regenerate any time during the two successive fires, then:

$$\frac{\sum_{i=1}^{M} \Delta OS_i}{M} = \frac{ITFI}{2} \quad (5)$$

ΔETA is also about half of ITFI for sampling time could be any time during two successive fires:

$$\frac{\sum_{i=1}^{M} \Delta ETA_i}{M} = \frac{ITFI}{2} \quad (6)$$

Applying these two equations, we get:

$$ITFI = \frac{\sum_{i=1}^{M} TA_i - M \cdot ITFI/2 - M \cdot ITFI/2}{\sum_{i=1}^{M} SN_i - M} = \frac{\sum_{i=1}^{M} TA_i - M \cdot ITFI}{\sum_{i=1}^{M} SN_i - M} \quad (7)$$

Multiplying both sides of the equation by $\sum_{i=1}^{M} SN_i - M$, we get:

$$ITFI \cdot \sum_{i=1}^{M} SN_i - M \cdot ITFI = \sum_{i=1}^{M} TA_i - M \cdot ITFI \quad (8)$$

$$ITFI \cdot \sum_{i=1}^{M} SN_i = \sum_{i=1}^{M} TA_i \quad (9)$$

$$ITFI = \frac{\sum_{i=1}^{M} TA_i}{\sum_{i=1}^{M} SN_i} \quad (10)$$

This shows that the last formula is equivalent to the method proposed by Baker and Ehle (2001).