A Guide to Estimating Fire Rate of Spread In Spinifex Grasslands (Mk2)

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Notes:
This model applies to spinifex-dominated grasslands that are:

- 6-20 years old
- fuel load 3.5 -12 t/ha
- cover 25-45%
- height 20-40 cm
- clump profile moisture content 10-35%

The model explained about 79% of the variation in rate of spread of ~80 experimental fires in the Great Sandy and Gibson Deserts so does not cover the entire range of potential burning conditions.

The model does not incorporate long distance spotting, which is not a common feature of spinifex fires.

If there is significant cured soft grass and herb in-fill following exceptional rainfall, or there is >70% cover of spinifex, consider using the grassland model.

The use of the Australian Water Availability Project data (http://www.csiro.au/awap/) for estimating the moisture content of live spinifex clumps has had limited testing, but shows promise for sub-regional scale estimates, even though it is a relative rather than actual measure of soil moisture.

Spinifex meadows will not always fit neatly into one of the five fuel classes shown below so choose the class that most closely resembles your situation.

Due to insufficient experimental data, rate of spread estimates for Class 5 spinifex fuels (20+ years old) are not included. As reflected by the model equation below, after peaking at 20-30 years, fuel quantity and cover often declines in very old spinifex.

Direct measurement of model inputs is preferred but not always feasible, hence indirect measures are included.

A Mk3 spinifex fire behaviour model is currently being developed but will not be ready for operational use until mid 2015.

Two-step process: Step 1: Will fire spread?

SI = 0.57(U) + 0.96(Q) – 0.42(PMC) -7.4

Where:

SI = spread index.
If SI < 0, then the fire is *unlikely* to spread (no-go) – the more negative the SI, the less likely is fire spread. Further calculations may be unwarranted.
If the SI > 0, then the fire is *likely* to spread (go-go) – the more positive the SI, the more likely is fire spread. Go to the next step and calculate the likely Rate of Spread.

U = wind speed @ 2m (km/h). Open wind speed will be approximately 1.2 x wind speed at 2 m.
Q = fuel quantity (t/ha oven dry) (see below)
PMC = clump profile moisture content (% oven dry) (see below)

Step 2: If SI > 0, calculate Rate of Spread

$ROS = 155(U) + 141(Q) – 230(PMC) + 1580$

Slope Correction:

$ROS_{sl} = ROS * e^{0.068S}$

(Follows McArthur's rule – double slope = double ROS)

Where:

ROS = Rate of Spread (km/h) on level ground
S = slope (degrees)
ROS_{sl} = Rate of Spread (m/h) corrected for positive slope

1. Estimating fuel quantity (Q; t/ha)

1A: Directly by destructive sampling (preferred)

1B: Indirectly from fuel age (time since last fire)

Fuel quantity (t/ha) = 1.21(fuel age yrs) X $(e^{-0.041 \times \text{fuel age}})$

1C: Indirectly from fuel structure (see below).

2. Estimating the moisture content of spinifex clumps (Profile Moisture Content- PMC)

2A: Direct measurement using moisture meter (preferred)

2B: Indirect from clump colour (under development)

2C: Indirect estimate from relative soil moisture (under evaluation)

Class 2 spinifex fuel (6-10 years old):
$PMC\ (\%) = 40.4(AWAP_{UF}) + 18.5\ (\sqrt{(RH/20)})$

Class 3 spinifex fuel (11-15 years old):
$PMC\ (\%) = 40.4(AWAP_{UF}) + 14.5\ (\sqrt{(RH/20)})$

Class 4 spinifex fuel (16-20 years old):
$PMC\ (\%) = 40.4(AWAP_{UF}) + 10.5\ (\sqrt{(RH/20)})$

Where:

PMC = Clump profile moisture content (%)
RH = relative humidity
$AWAP_{UF}$ = Australian Water Availability Project http://www.csiro.au/awap/
Use relevant Monthly Relative Soil Moisture (Upper Layer) Fraction" value from map

Heading

Class 1 (<6 years old)

Spinifex seedlings mostly <15 cm tall and <15cm wide. Plants are discrete, mostly separated. No dead leaves or stolons in centre of plant. Some residual stolons from pre-fire plants and some fresh charcoal evident on woody material. No flower or stalks on spinifex. Epicormic shoots may be evident on trees and shrubs. Soft grasses and herbs may be abundant.

Cover spinifex live (%)	Cover spinifex dead (%)	Cover Other (%)	Cover fuel total (%)	Bare ground (%)	Spinifex ht (cm)	Fuel load (t/ha)
15-20	0	15-25	20-40	60-80%	<15	<3.5

Rate of Spread (m/h)

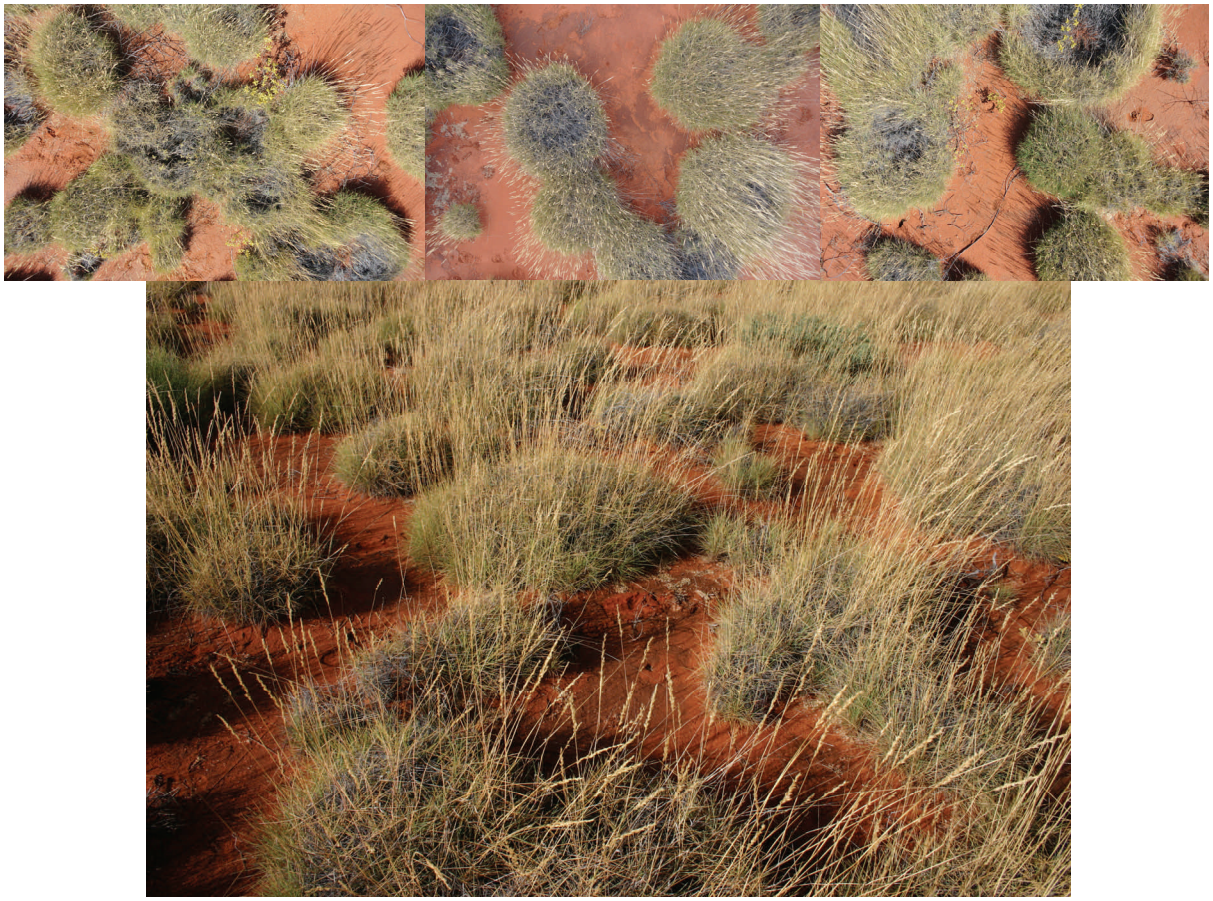
Fire is unlikely to spread in this fuel class unless there is a continuous (>70%) cover of cured soft grass and/or herbs, which can occur on some sites, especially following exceptional rainfall. In this situation, the Grass Fire Model applies.

Class 2 (6-10 years old)

Mostly discrete, compact hummocks, some joined. No or few dead (black/grey) leaves or stems evident in hummocks. Spinifex flower/stalks present. Most plants 20-30 cm tall and 20-30 cm wide. Some soft grasses and herbs present.

Cover spinifex live (%)	Cover spinifex dead(%)	Cover Other (%)	Cover fuel total (%)	Bare ground (%)	Spinifex ht (cm)	Fuel load (t/ha)
30-40	0	5-10	40-50	50-60	**Hi**: 25-30 **Lo**: 20-25	6.5 4.5

	Wind speed (km/h) Rate of Spread (m/h)						
PMC (%)	**10**	**15**	**20**	**25**	**30**	**35**	**40**
35 Hi **Lo**	0 0	0 0	0 0	0 0	0 0	190 0	960 680
30 Hi **Lo**	0 0	0 0	0 0	0 0	520 240	1290 1010	2060 1780
25 Hi **Lo**	0 0	0 0	100 0	840 560	1620 1340	2390 2110	3160 2880
20 Hi **Lo**	0 0	390 0	1160 880	1940 1660	2720 2440	3490 3210	4260 3980
15 Hi **Lo**	0 0	1490 1210	2270 1990	3040 3780	3820 3540	4590 4310	5360 5080
10 Hi **Lo**	1810 0	2590 2310	3370 3080	4140 3860	4920 4640	5690 5410	6460 6180



Class 3 (11-15 years old)

Plants are roughly circular, dome-shaped clumps 20-35 cm high, 20-50 cm wide. Many discrete, but many are joined. Most have dead (black/grey) leaves and stems forming in the centre of the hummock and in the growing front. Spinifex flower/stalks present.

Cover spinifex live (%)	Cover spinifex dead(%)	Cover Other (%)	Cover fuel total (%)	Bare ground (%)	Spinifex ht (cm)	Fuel load (t/ha)
35-45	3-5	3-6	45-55	45-55	**Hi**: 30-35 **Lo**: 25-30	8.5 6.5

	Wind speed (km/h) Rate of Spread (m/h)						
PMC (%)	**10**	**15**	**20**	**25**	**30**	**35**	**40**
35 Hi	0	0	0	0	0	470	1250
Lo	0	0	0	0	0	0	960
30 Hi	0	0	0	0	800	1570	2350
Lo	0	0	0	0	520	1290	2060
25 Hi	0	0	350	1120	2000	2670	3450
Lo	0	0	0	840	1620	2390	3160
20 Hi	0	670	1450	2220	3000	3770	4550
Lo	0	390	1160	1940	2720	3490	4260
15 Hi	1000	1770	2550	3320	4100	4870	5650
Lo	0	1490	2270	3040	3820	4590	5360
10 Hi	2100	2870	3650	4420	5200	5970	6740
Lo	0	2590	3370	4140	4920	5690	6460

Class 4 (16-20 years old)

Oldest plants have formed ‘donuts’ up to 3 m diameter with bare ground or sparse dead stems in the centre and usually a narrow band of dead stems behind the live front. Sometimes the growing front is fragmented. These meadows can be mixed age, with some younger plants.

Cover spinifex live (%)	Cover spinifex dead(%)	Cover Other (%)	Cover fuel total (%)	Bare ground (%)	Spinifex ht (cm)	Fuel load (t/ha)
25-35	6-15	5-10	45-55	45-55	**Hi**: 35-40 **Lo**: 25-35	10.5 8.5

	Wind speed (km/h) Rate of Spread (m/h)						
PMC (%)	**10**	**15**	**20**	**25**	**30**	**35**	**40**
35 Hi	0	0	0	0	100	785	1560
Lo	0	0	0	0	0	475	1248
30 Hi	0	0	0	330	1110	1885	2660
Lo	0	0	0	50	830	1600	2380
25 Hi	0	0	660	1430	2210	2980	3760
Lo	0	0	380	1150	1930	2700	3480
20 Hi	210	980	1760	2530	3310	4080	4860
Lo	0	700	1480	2250	3030	3800	4580
15 Hi	1310	2080	2860	3630	4410	5180	5960
Lo	1030	1800	2580	3350	4130	4900	5680
10 Hi	2410	3180	3960	4730	5510	6390	7060
Lo	2130	2900	3680	4450	5230	6000	6770