Field guide for classifying standard fire behavior fuel models in sagebrush steppe

Sam "Jake" Price[1], Chad Kluender[1], Matthew J Germino*[1]

US Geological Survey, Boise, Idaho

Steven Jimenez, Taylor Zarifis, Lance Okeson

Bureau of Land Management, Boise, Idaho

*for correspondence: mgermino@usgs.gov

Peer-reviewed US Geological Survey Information Product #170026

Presentation release date 26 September 2024

USGS science for a changing world

FIREss: Fire, Invasives, and Restoration Ecology of Sagebrush Steppe

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF LAND MANAGEMENT

Introduction and purpose

Fire behavior modeling is useful for planning and evaluating fuels and post-fire restoration treatments aimed at breaking the grass-fire cycle currently plaguing many arid and semi-arid habitats, globally. Additionally, existing fuels and active wildfire management planning tools, such as the Interagency Fuel Treatment Decision Support System and Wildland Fire Decision Support System (iftdss.firenet.gov and wfdss.usgs.gov, respectively) utilize fire behavior modeling to inform treatment placement and support active wildfire suppression. Modeling efforts, however, require fuel bed inputs such as fuel loading, bulk density, heat content, and moisture of extinction. Conveniently, these fuel-bed inputs have been assembled into libraries of fire behavior fuel models (FBFMs; Anderson 1982, Scott and Burgan 2005), which allow practitioners to quickly characterize potential fire behavior for a wide range of site conditions and ecosystems using photo guides. Available photo guides for fuel model libraries, however, span the entirety of the U.S. which can lead to some user difficulty owing to regional nuances in fuel characteristics and expected fire behavior.

Here we provide a photo guide for use in classifying FBFMs from the Scott and Burgan (2005) library that are common to the sagebrush steppe of the American west. The goal of this guide is to enable the quick and easy classification of fuel models in sagebrush steppe to, A) enhance the mapping of fuel beds in an increasingly fire prone region, B) guide the evaluation of fuel and post-fire restoration treatments, and C) improve our understanding of fuel conditions during times of the year when wildfire preparedness is greatest (i.e. hot and dry).

Photos and physical measurements were collected as part of greater monitoring efforts evaluating pre- and post-fire landscapes throughout the Snake River Plain and Northern Great Basin ecoregions of southern Idaho. The development of this photo guide relied heavily on input from experts in the Bureau of Land Management with experience in both fuels management and active wildfire suppression in sagebrush-steppe ecosystems.

There are at least two existing photo guides for vegetative fuels in sagebrush steppe, however, these guides do not relate fuel conditions to standard fire behavior fuel models as done here (Bourne and Bunting 2011, Shinneman et al. 2018). Instead, these previously published photo guides relate the depicted plant community conditions to various important fuel metrics including fuel loading, fuel bulk density, and cover based on geographically dispersed, detailed sampling within the SageSTEP project (Bourne and Bunting 2011) or from the Snake River Birds of Prey National Conservation Area (Shinneman et al. 2018).

Recommended citation: *Price, S.J., Kluender, C.R., Germino, M.J., Jimenez, S., Zarifis, T., Okeson, L., 2024. Field guide for classifying standard fire behavior fuel models in sagebrush steppe. https://greatbasinfirescience.org/.*

Considerations when using this field guide

- Fuel model classifications reflect expert opinions as to the likely fire behavior expected given the **foreground** of each photograph.
- Fuels monitoring should take place at or near when yearly peak fuel biomass occurs (see Bates et al. 2023 for an example of phenological guidance).
- Fuel bed characterizations made in this field guide reflect hot and dry conditions from times in the year when wildfire preparedness is at its greatest.
- Fuel model classifications are made without consideration for slope or aspect.
- Organization: Each Fuel-Bed Fire Model (FBFM) relevant to sagebrush steppe is described and followed by 3 to 7 examples of different plant communities that align with the FBFM. The text accompanying each photo explains the condition of the vegetative fuels and rationale for assigning the community to the respective FBFM.
- Miscellaneous information:
  - Acronyms: PG = large statured perennial grasses (does not include *Poa secunda*).
    - Large statured perennial grasses (PG) in sagebrush steppe tend to be deeper rooted, longer lived and actively grow through a greater portion of the year than species such as *Poa secunda*, which are shallow rooted, short lived, and enter dormancy earlier in the growing season.
  - Bare soil does not include rocks.
  - The dominant annual grass was *Bromus tectorum.*

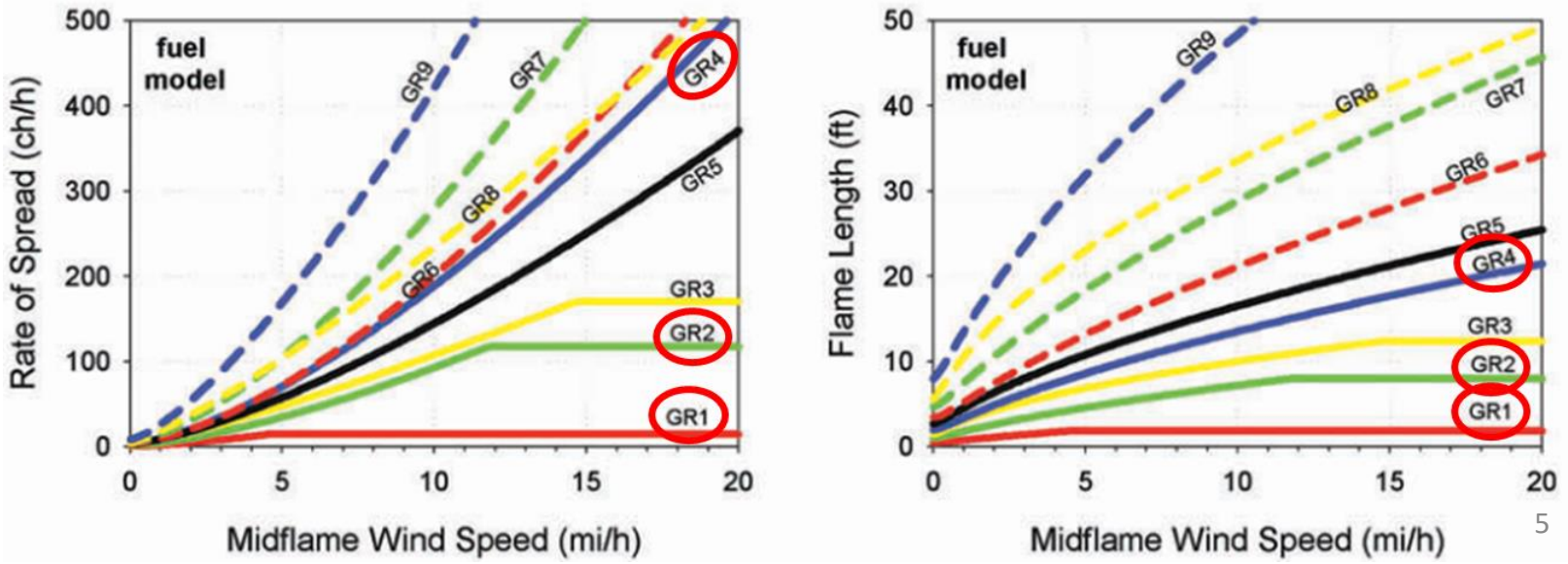
Tips for visually classifying fuel beds

- Size and shape of fuels
  - Consider the texture and height of fuels.
    - Fine-texture fuels are readily ignited but generate less energy when combusting. Coarse-texture fuels require more energy to ignite but are capable of emitting more energy than fine-textured fuels.
    - Short fuels cast a small flame which ineffectively pre-heats fuels ahead of the flaming front. Tall fuels are capable of casting large flames which more effectively pre-heats fuels.
- Compactness and arrangement of fuels
  - Consider how fuel height and biomass interact to affect ignitability and energy transmission.
    - Dense fuel beds (i.e. short fuels with a lot of biomass) can require more energy from the flaming front to ignite relative to diffuse fuel beds. Upon ignition these fuel beds can emit large amounts of energy.
    - Diffuse fuel beds (i.e. tall with not a lot of biomass) may be readily ignitable, however, upon ignition are not likely to emit much energy.
- Fuel connectivity
  - Fuel connectivity greatly effects wildfire rates of spread (i.e. how fast the fire is able to consume and ignite adjacent unburnt fuels).
    - The presence of breaks in fuel connectivity allows for the entrainment of cold air. This reduces the efficacy of convective heat transfer near the flaming front and thus reduces rates of fire spread.
    - Alternatively, dense fuel canopies can inhibit the mixing of air near the flaming front, thus limiting the entrainment of oxygen (a necessary component for sustained combustion).

Grass dominated fuel beds (GR)

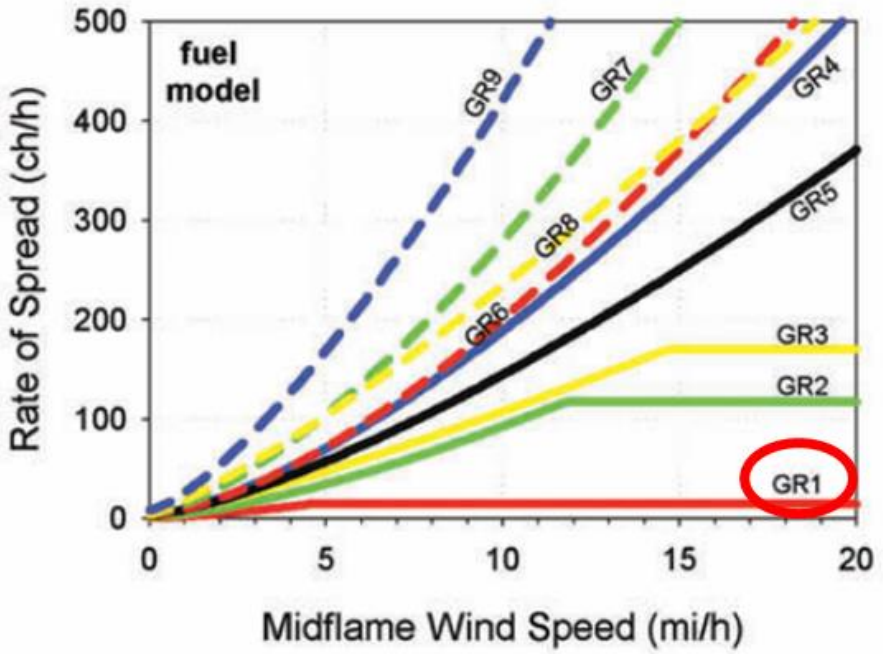
- The primary carrier of fire in the GR fuel models is grass.
- All GR fuel models are dynamic, meaning that their live herbaceous fuel load will shift from live to dead as a function of live herbaceous fuel moisture content. The effect of live herbaceous fuel moisture content is strong.
- GR1 - short, sparse, dry-climate grassland
- GR2 - low load, dry climate grass
- GR4 - moderate load, dry climate grass

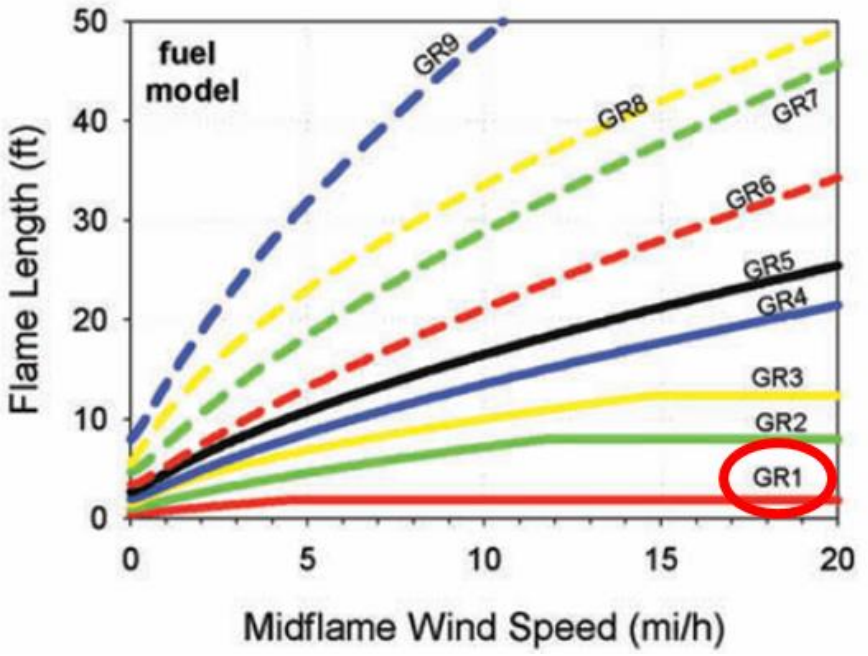
Figures: Expected fire behavior of each of the FBFMs described by Scott and Burgan (2005; reproduced here) as modeled by the fire simulation software “Behave+”.



GR1 - short, sparse, dry-climate grassland

- The GR1 fuel model is the least vegetated with the sparsest fuel loading and lowest expected fire behavior of all available fuel models from the Scott and Burgan (2005) dataset.
- In GR1, the dominant fuels contributing to wildfire behavior are short and/or very sparse grasses with bare ground present. If perennial-grass dominated, fuels are ~30 cm tall with large interspaces dominated by bare ground. Perennial grass canopies overlap very little or not at all. If annual-grass dominated, fuels are < 30 cm tall and bare ground is present either between individuals (i.e. low-density annuals) or in large patches.





Figures: Expected fire behavior of each of the FBFMs described by Scott and Burgan (2005; reproduced here) as modeled by the fire simulation software "Behave+".

GR1: Example 1

Shrub fuels are sparse with considerable distance between individuals, such that they are unlikely to contribute to wildfire spread.

Surface fuels dominated by annual grasses and scattered forbs. Herbaceous fuels are short (< 30 cm) and patchy. Considerable bare ground present.

Shrub cover: 7.5%
PG cover: 2.5%
Annual grass cover: 25%
Bare soil cover: 12.5%

GR1: Example 2

Shrub fuels are short and sparse with considerable distance between individuals, such that they are unlikely to contribute to wildfire spread.

Large-statured perennial grasses appear to have been grazed. There is little to no canopy connectivity between perennial grasses. Interspaces dominated by short (< 30 cm), low density annual grasses with some patchy bare soil.

Shrub cover: 7.5%
PG cover: 17.5%
Annual grass cover: 25%
Bare soil cover: 5%

GR1: Example 3

Shrub fuels are short and sparse with considerable distance between individuals, such that they are unlikely to contribute to wildfire spread.

Fuel bed dominated by *Poa secunda* and short-statured forbs, such as *Blepharipappus scaber* in this particular example. Bare ground present in patches.

Shrub cover: 5%
PG cover: 7.5%
Annual grass cover: 12.5%
Bare soil cover: 7.5%

GR1: Example 4

Large-statured perennial grasses are ~ 30 cm tall and lack overlapping canopies. Interspaces dominated by a mix of short-statured *Poa secunda* and *Phlox spp*. Annual grasses are present but patchy.

Shrub cover: 0%
PG cover:17.5%
Annual grass cover: 15%
Bare soil cover: 7.5%

GR1: Example 5

Large-statured perennial grasses are 30-60 cm tall but have little to no canopy overlap. Large interspaces dominated by bare soil are abundant.

Shrub cover: 7.5%
PG cover: 27.5%
Annual grass cover: 7.5%
Bare soil cover: 17.5%

GR1

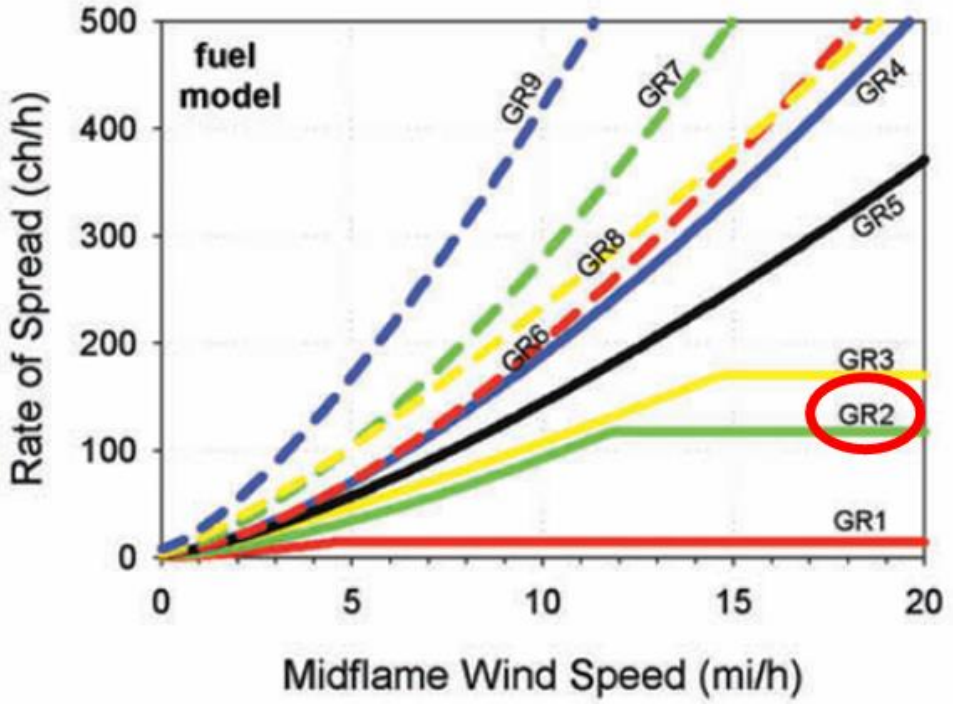
Large-statured perennial grass species are 30-60 cm tall but have low canopy connectivity.

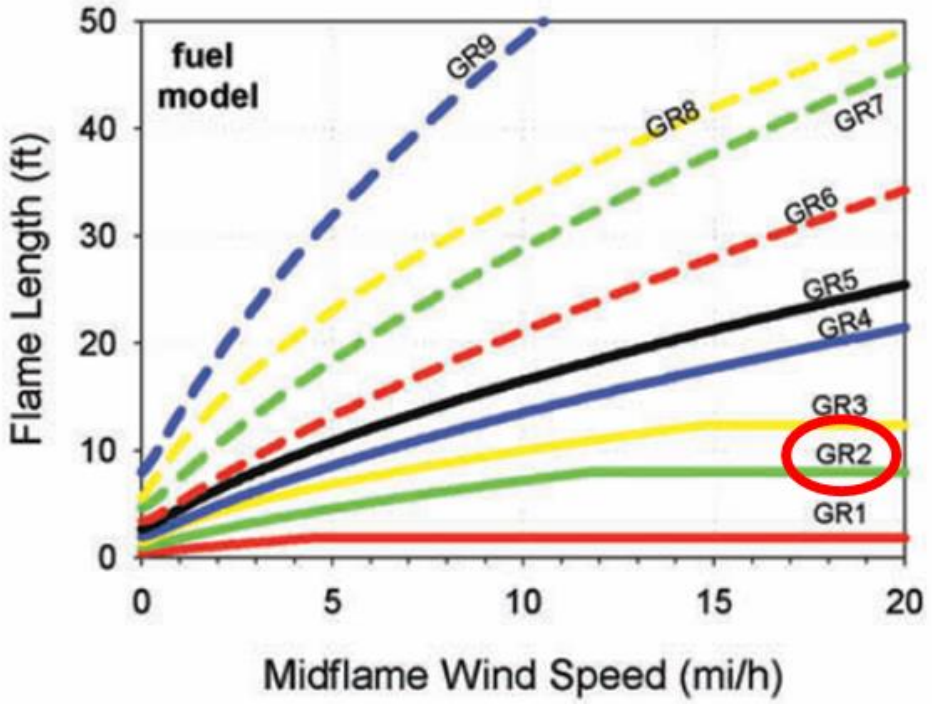
In the foreground, interspaces are dominated by bare soil. Short annual grasses (< 30 cm tall) are present, but very patchy.

Shrub cover: 2.5%
PG cover: 27.5%
Annual grass cover: 12.5%
Bare soil cover: 7.5%

GR2 - Low load, dry climate grass

- Relative to GR1, fuel loads and connectivity are greater in GR2. Dominant fuels are > 30 cm tall but < 60 cm tall. This fuel bed likely consists of combinations of annual grasses, perennial grasses, and herbaceous litter. Bare ground is present, but much reduced relative to GR1.





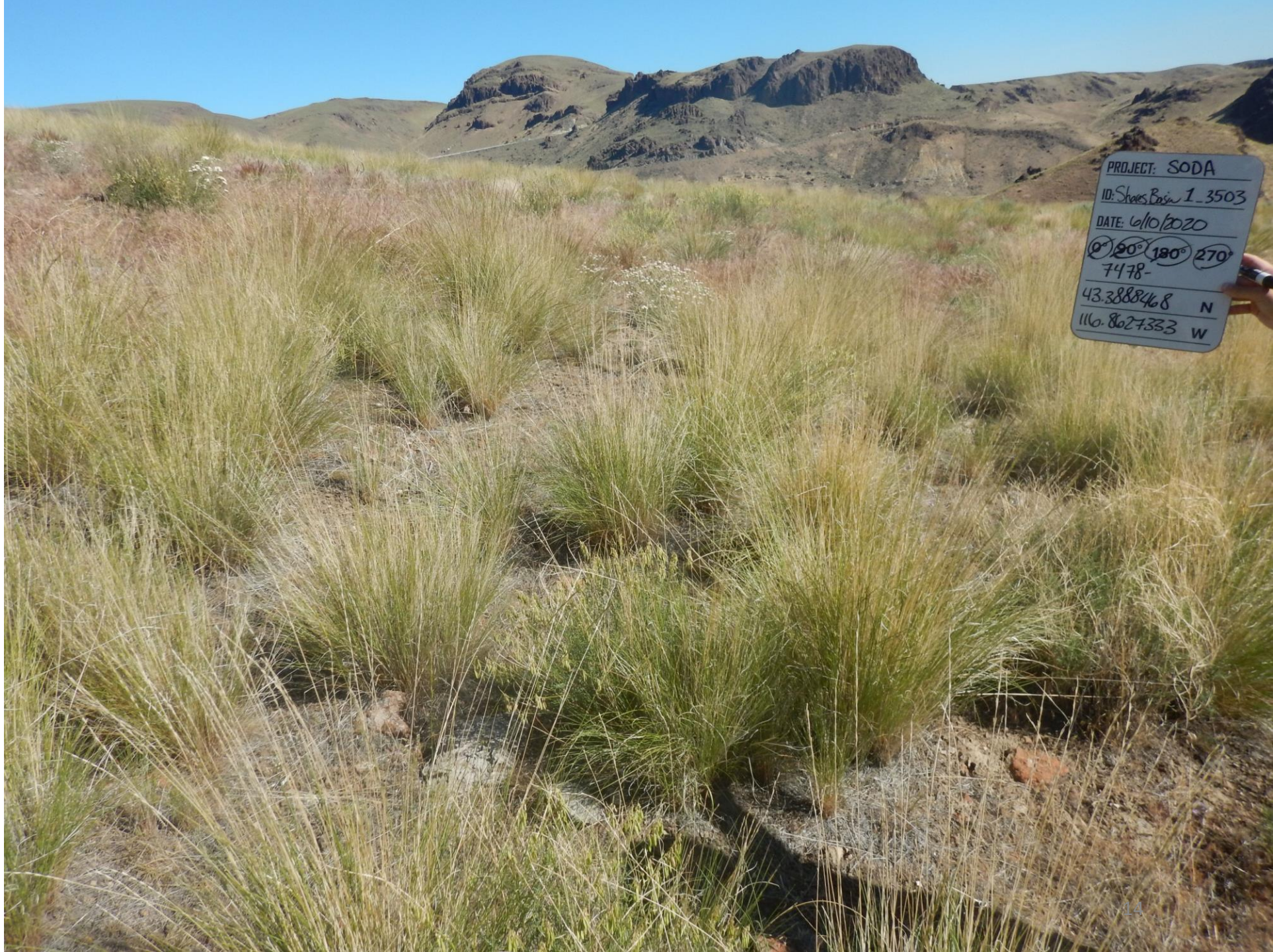
Figures: Expected fire behavior of each of the FBFMs described by Scott and Burgan (2005; reproduced here) as modeled by the fire simulation software "Behave+".

GR2: Example 1

Large-statured perennial grasses are 30-60 cm tall with moderate canopy connectivity.

Interspaces are dominated by herbaceous litter with some bare ground.

Shrub cover: 7.5%
PG cover: 27.5%
Annual grass cover: 17.5%
Bare soil cover: 2.5%



GR2: Example 2

Large statured perennial grasses are < 30 cm tall and sparse. Bare soil is evident around perennial grasses.

Remaining fuel bed is dominated by short (< 30 cm tall) annual grasses.

Shrub cover: 0%
PG cover: 17.5%
Annual grass cover: 37.5%
Bare soil cover: 2.5%

GR2: Example 3

Large statured perennial grasses (*Sporobolus cryptandrus*) are moderately dense and 30-60 cm tall. Interspaces dominated by short (< 30 cm tall) annual grasses. Bare soil is minimal.

Shrub cover: 0%
PG cover: 25%
Annual grass cover: 37.5%
Bare soil cover: 2.5%

GR2: Example 4

Fuel bed dominated by 30-60 cm tall annual grasses with very little bare soil exposure.

Shrub cover: 0%
PG cover: 2.5%
Annual grass cover: 65%
Bare soil cover: 2.5%

GR2: Example 5

Large-statured perennial grasses are 30-60 cm tall, and interspaces dominated by 30-60 cm tall annual grasses. There is very little bare soil exposure.

Shrub cover: 2.5%
PG cover: 27.5%
Annual grass cover: 22.5%
Bare soil cover: 2.5%

GR2: Example 6

Large statured perennial grasses (*Leymus cinereus*) in this photo are tall (> 60 cm) but sparse. Interspaces between perennial grasses dominated by tall annual grasses (30-60 cm) with a mix of short statured *Poa secunda.* Bare ground is present, but patchy.

Shrub cover: 2.5%
PG cover: 12.5%
Annual grass cover: 45%
Bare soil cover: 2.5%

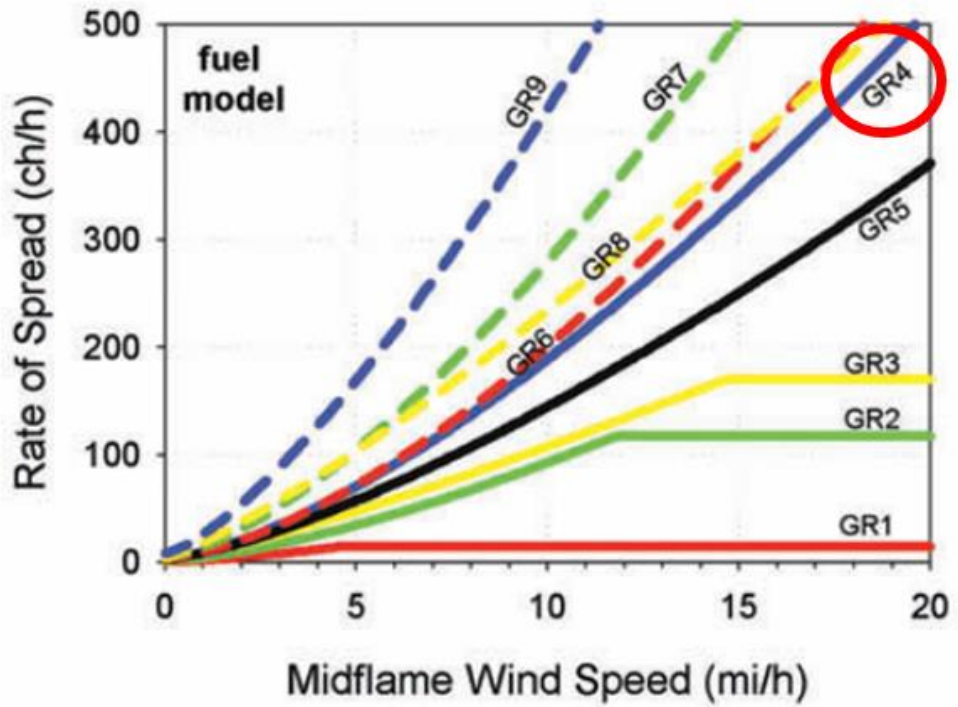
GR2: Example 7

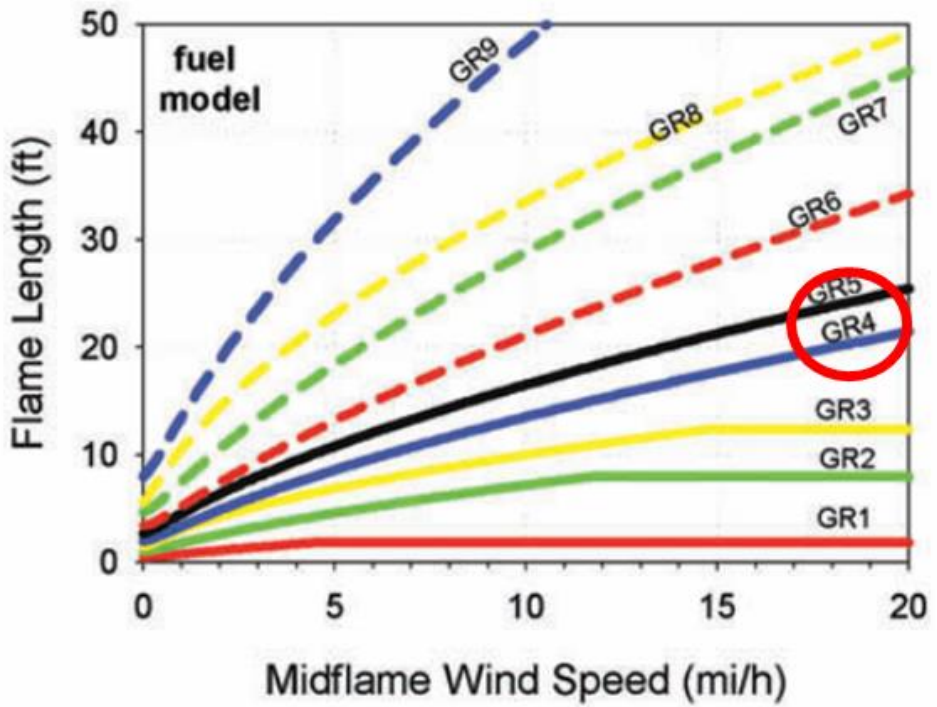
Large statured perennial grasses are 30-60 cm tall but sparse. Interspaces are dominated by annual grasses with some *Poa secunda*. Bare soil exposure is minimal.

Shrub cover: 0%
PG cover: 17.5%
Annual grass cover: 27.5%
Bare soil cover: 2.5%

GR4 – Moderate load, dry climate grass

- Relative to GR1 and GR2, fire spread is much greater due to increased height of fuels and near continuous herbaceous canopy. Bare ground is minimal to none. Fuels are 60-90 cm tall.





Figures: Expected fire behavior of each of the FBFMs described by Scott and Burgan (2005; reproduced here) as modeled by the fire simulation software "Behave+".

GR4: Example 1

Annual grasses are tall (60-90 cm) and continuous.

Shrub cover: 0%
PG cover: 2.5%
Annual grass cover: 65%
Bare soil cover: 2.5%

GR4: Example 2

Large statured perennial grasses are 60-90 cm tall and create a connected canopy. Interspaces between bunchgrasses are dominated by herbaceous litter with some annual grasses present.

Shrub cover: 0%
PG cover: 65%
Annual grass cover: 17.5%
Bare soil cover: 2.5%

GR4: Example 3

Perennial grasses are tall (60-90 cm) and continuous.

Shrub cover: 0%
PG cover: 65%
Annual grass cover: 2.5%
Bare soil cover: 2.5%

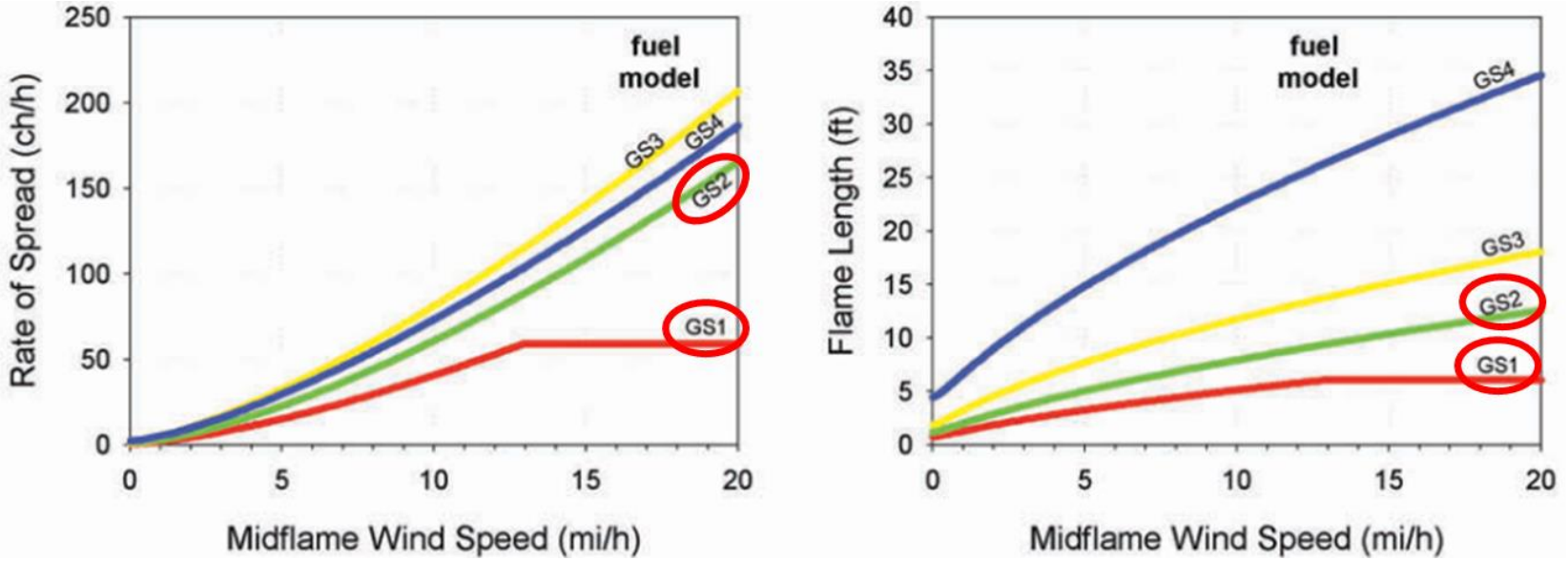
GR4: Example 4

Annual grasses are tall (60-90 cm) and continuous.

Shrub cover: 0%
PG cover: 12.5%
Annual grass cover: 55%
Bare soil cover: 7.5%

Grass shrub dominated fuel beds (GS)

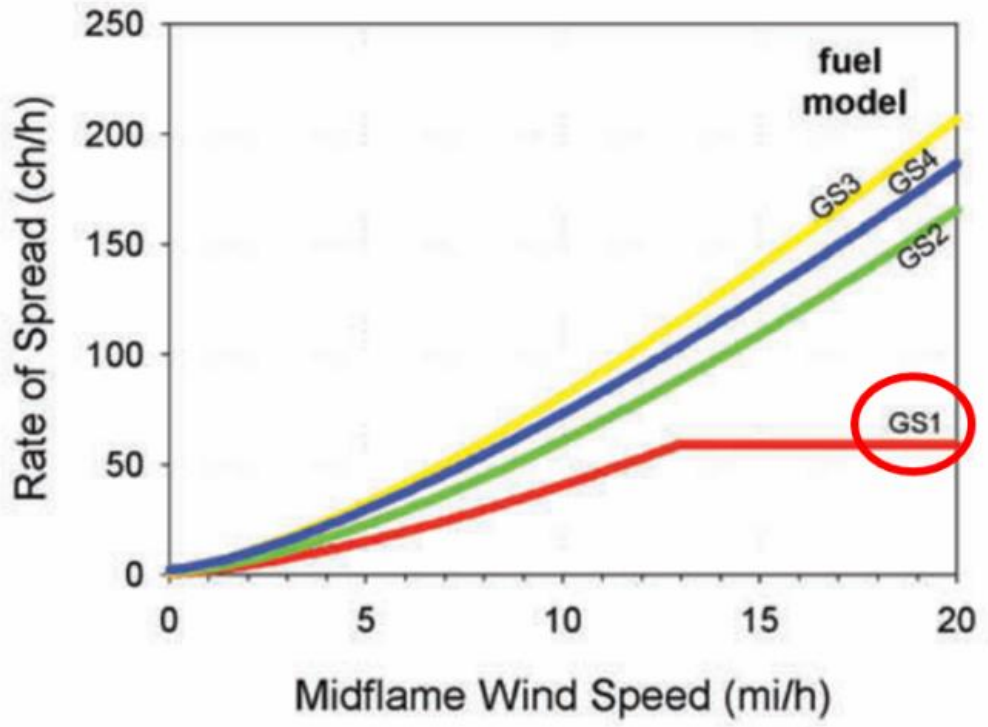
- The primary carrier of wildfire in the GS fuel models is the combination of grasses and shrubs.
- All GS fuel models are dynamic, meaning that their live herbaceous fuel load will shift from live to dead as a function of live herbaceous fuel moisture content. The effect of live herbaceous fuel moisture content on rates of spread and reaction intensity are dependent on the relative amount of grass to shrub fuels.
- GS1 - low load, dry climate grass-shrub
- GS2 - moderate load, dry climate grass-shrub

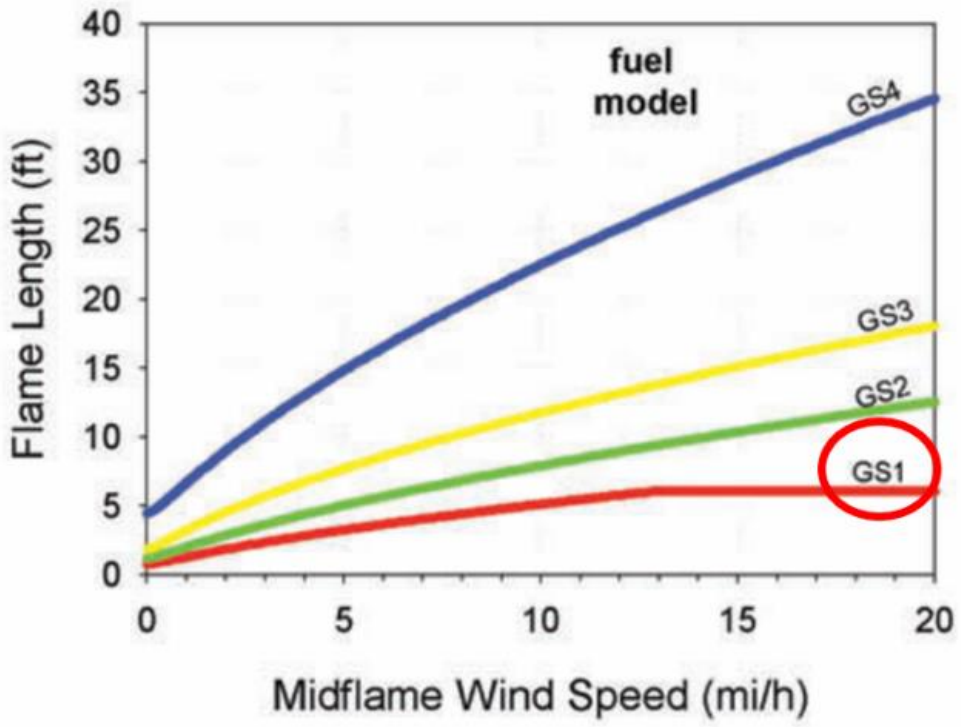


Figures: Expected fire behavior of each of the FBFMs described by Scott and Burgan (2005; reproduced here) as modeled by the fire simulation software "Behave+".

GS1 – Low load, dry climate grass-shrub

- Dispersed, short shrubs (30-60 cm) with grass fuels present in the interspaces. Grass fuel loading is low to moderate.





Figures: Expected fire behavior of each of the FBFMs described by Scott and Burgan (2005; reproduced here) as modeled by the fire simulation software "Behave+".

GS1: Example 1

Shrubs are 30-60 cm tall. Interspaces between shrubs dominated by tall annual grasses.

Shrub cover: 37.5%
PG cover: 0.5%
Annual grass cover: 45%
Bare soil cover: 3%

GS1: Example 2

CRMO_31_18

Shrubs are 30-60 cm tall. Interspaces between shrubs dominated by a mix of ~ 30 cm tall perennial grasses and < 30 cm tall annual grasses.

Shrub cover: 22.5%
PG cover: 12.5%
Annual grass cover: 22.5%
Bare soil cover: 7.5%

GS1: Example 3

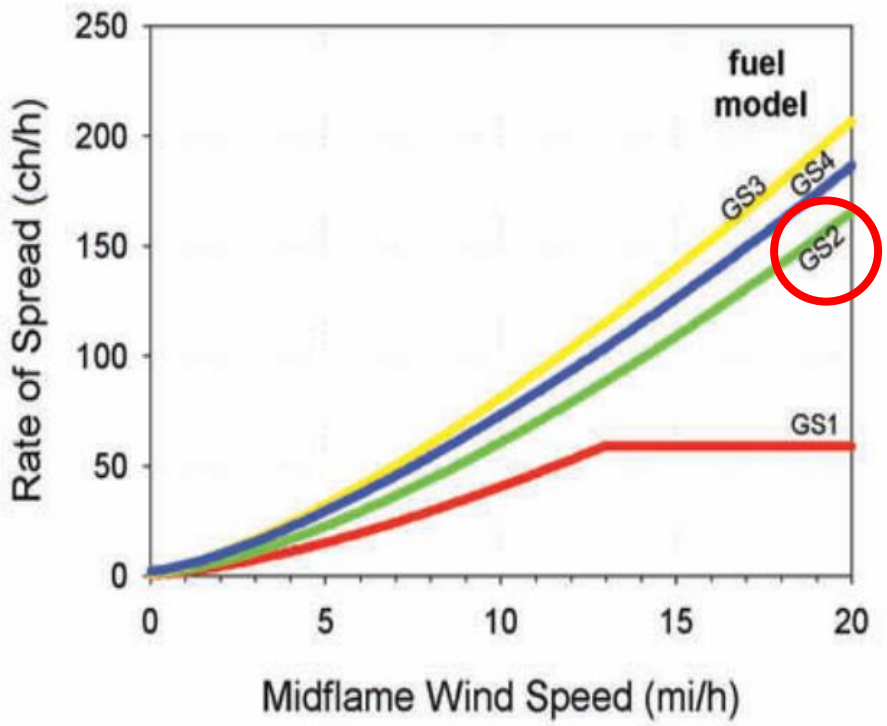
CRMO_10_185

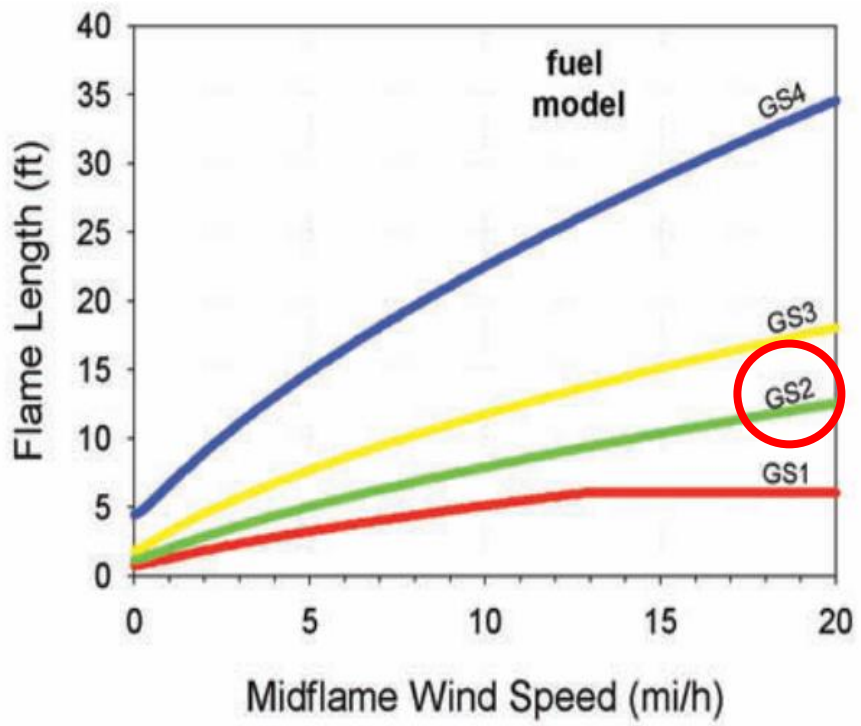
Shrubs are 30-60 cm tall with low-moderate canopy connectivity. Interspaces between shrubs dominated by ~30 cm tall perennial grasses. Some bare ground and annual grasses are present as well.

Shrub cover: 32.5%
PG cover: 12.5%
Annual grass cover: 3%
Bare soil cover: 27.5%

GS2 – Moderate load, dry climate grass-shrub

- Relative to GS1, shrubs are taller (60-90 cm tall), and grass fuel loading is greater.





Figures: Expected fire behavior of each of the FBFMs described by Scott and Burgan (2005; reproduced here) as modeled by the fire simulation software "Behave+".

GS2: Example 1

Shrubs are 60-90 cm tall with moderate to high canopy connectivity.

Gaps between shrubs dominated by30-60 cm tall perennial grasses and shrub litter.

Some annual grasses present. Bare soil limited to an animal trail running through the middle of the photo.

Shrub cover: 55%
PG cover: 27.5%
Annual grass cover: 12.5%
Bare soil cover: 2.5%

GS2: Example 2

Shrubs are ~30-90 cm tall with moderate canopy overlap.

Interspaces dominated by a mix of 30-60 cm tall large statured perennial grasses and annual grasses.

Shrub cover: 32.5%
PG cover: 22.5%
Annual grass cover: 27.5%
Bare soil cover: 0.5%

GS2: Example 3

GRTE_197

Shrubs are ~60-90 cm tall. Interspaces between shrubs are dominated by 30-60 cm tall perennial grasses.

Shrub cover: 45%
PG cover: 65%
Annual grass cover: 0%
Bare soil cover: 3%

GS2: Example 4

CRMO_1_10

Shrubs are 60-90 cm tall. Interspaces dominated by a mix of tall annual grasses and large statured perennial grasses.

Shrub cover: 22.5%
PG cover: 12.5%
Annual grass cover: 37.5%
Bare soil cover: 3%

GS2: Example 5

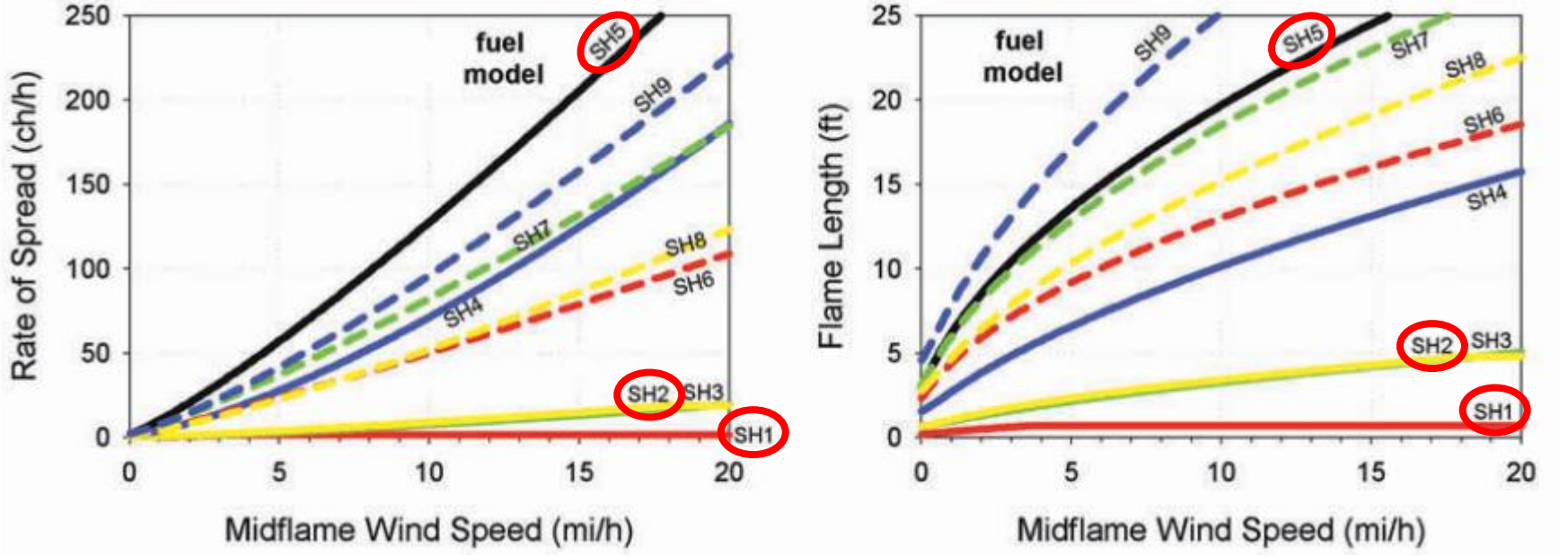
Shrubs are 60-90 cm tall with moderate canopy overlap.

Interspaces dominated by 30-60 cm tall perennial grasses.

Shrub cover: 65%
PG cover: 32.5%
Annual grass cover: 0%
Bare soil cover: 3%

Shrub dominated fuel beds (SH)

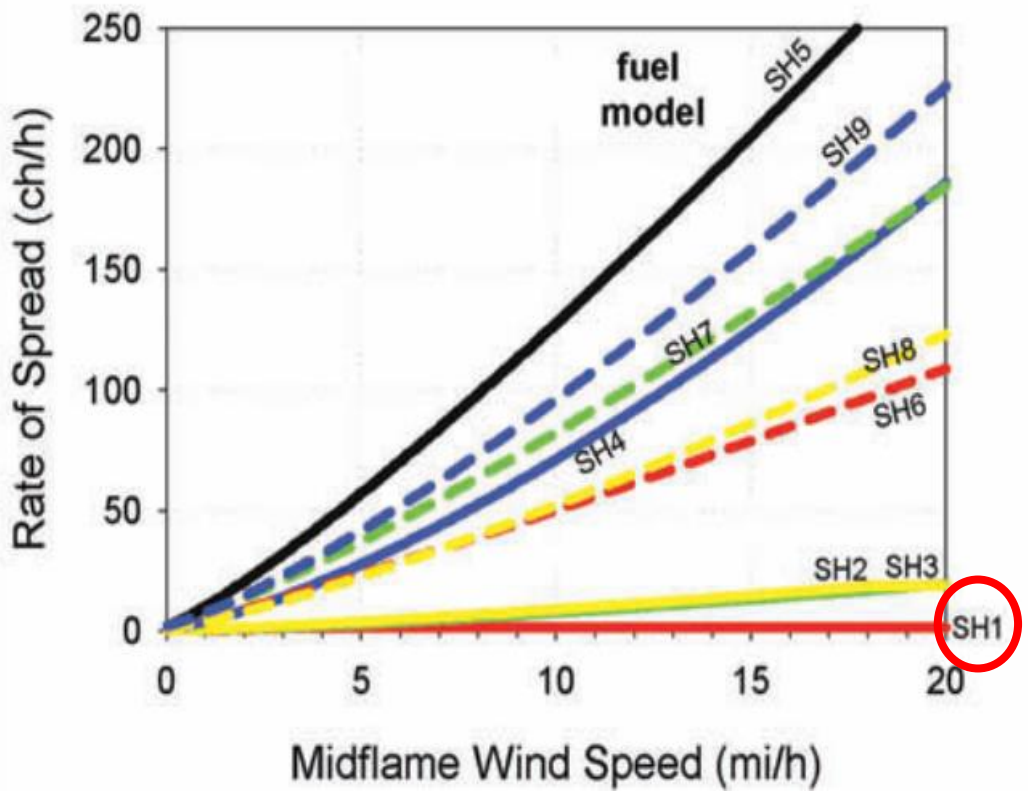
- The primary carrier of wildfire in the SH fuel models is live and dead shrub material, including foliage and shrub litter.
- SH1 - Low load, dry climate shrub
  - SH1 is a dynamic fuel model. The effect of live herbaceous moisture content will have a strong effect on rate of spread.
- SH2 - Moderate load, dry climate shrub
- SH5 - High load, dry climate shrub

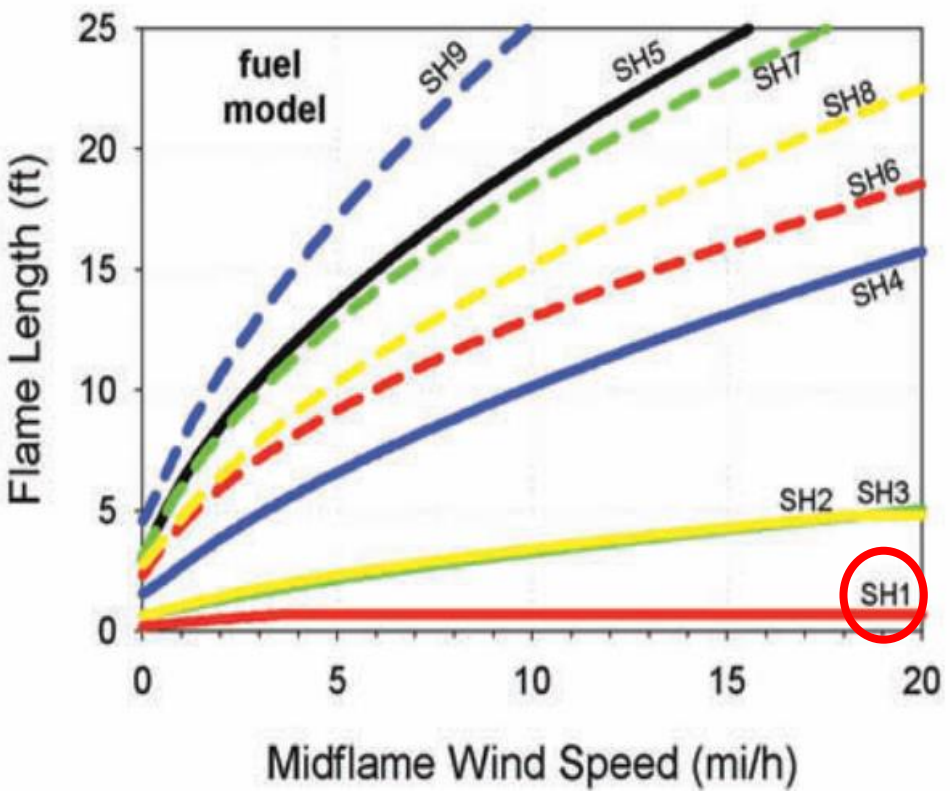


Figures: Expected fire behavior of each of the FBFMs described by Scott and Burgan (2005; reproduced here) as modeled by the fire simulation software "Behave+".

SH1 – Low load, dry climate shrub

- Short shrubs (30-60 cm tall) with low to moderate canopy connectivity. Small amounts of herbaceous fuels may be present in the understory. Interspaces between shrubs dominated by bare ground. Does not readily pass fire.





Figures: Expected fire behavior of each of the FBFMs described by Scott and Burgan (2005; reproduced here) as modeled by the fire simulation software "Behave+".

SH1 : Example 1
Shrubs are 30-60 cm tall with some canopy connectivity.

Large gaps between shrubs consist of short statured *Poa secunda* and bare soil.

Large statured perennial grasses are 30-60 cm tall but very sparsely arranged.

Shrub cover: 22.5%
PG cover: 7.5%
Annual grass cover: 0%
Bare soil cover: 15%

SH1: Example 2

Shrubs are abundant; however, they are very short (~ 30 cm) and bare ground exposure is considerable.

Shrub cover: 55%
PG cover: 2.5%
Annual grass cover: 0%
Bare soil cover: 15%

SH1: Example 3

Shrubs are ~30-60 cm tall with moderate canopy connectivity.

Large gaps between shrubs consist of short statured *Poa secunda* and bare soil.

Large statured perennial grasses are 30-60 cm tall but sparse.

Shrub cover: 22.5%
PG cover: 12.5%
Annual grass cover: 7.5%
Bare soil cover: 22.5%

SH1: Example 4

Shrubs are ~60 cm tall with moderate canopy connectivity.

Large gaps between shrubs consist of short statured *Poa secunda* and bare soil.

Large statured perennial grasses are ~ 30-60 cm tall but sparse.

Shrub cover: 27.5%
PG cover: 12.5%
Annual grass cover: 2.5%
Bare soil cover: 7.5%

SH1: Example 5

Shrubs are 30-60 cm tall with moderate canopy connectivity.

Interspaces between shrubs consist mostly of bare soil.

Large statured perennial grasses are 30-60 cm tall but sparse.

Shrub cover: 32.5%
PG cover: 12.5%
Annual grass cover: 2.5%
Bare soil cover: 12.5%

SH1: Example 6

Shrubs are ~60 cm tall with moderate canopy connectivity.

Large gaps between shrubs consist mostly of short statured *Poa secunda* and bare soil.

Large statured perennial grasses are 30-60 cm tall but sparse.

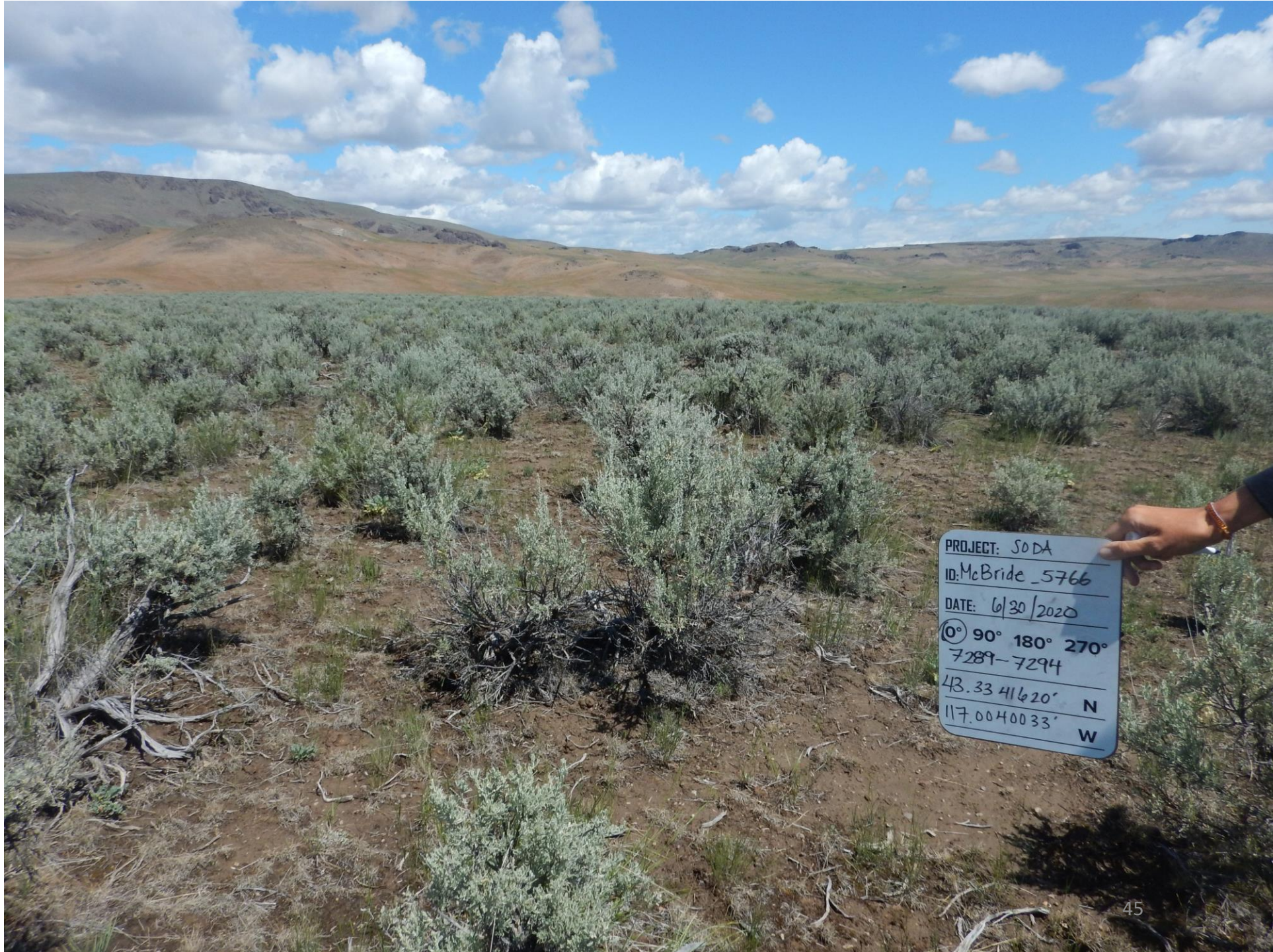
Shrub cover: 27.5%
PG cover: 12.5%
Annual grass cover: 2.5%
Bare soil cover: 12.5%

SH1: Example 7

Shrubs are ~ 60 cm tall with moderate canopy connectivity.

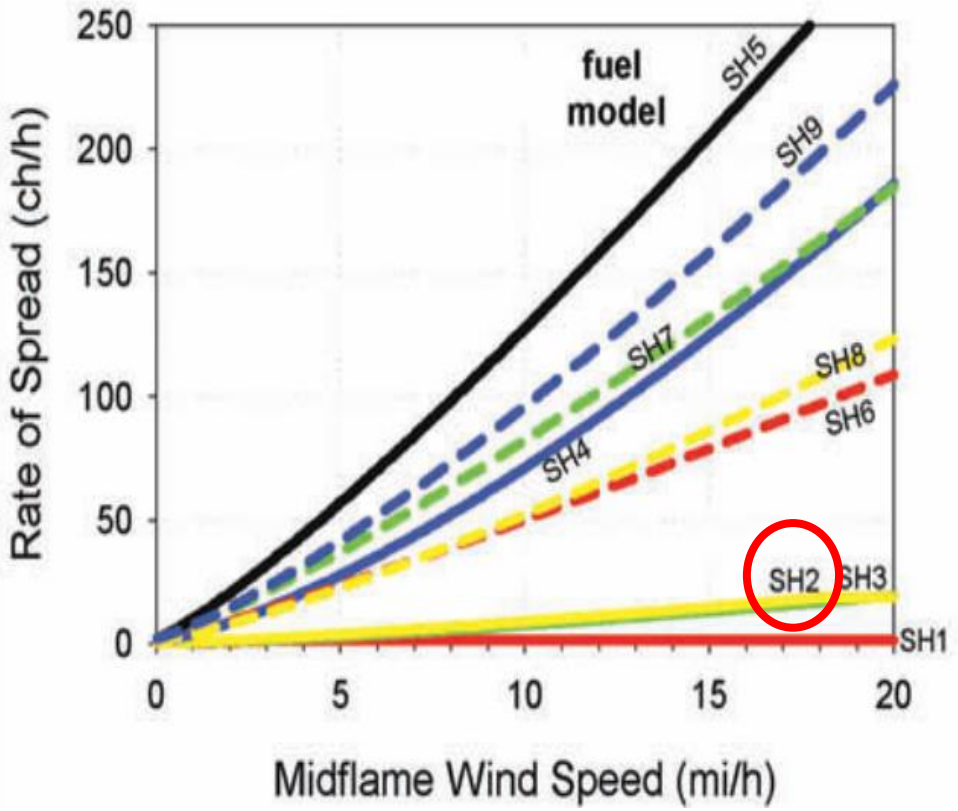
Interspaces between shrubs have some grass fuels present but are largely dominated by bare soil and shrub litter.

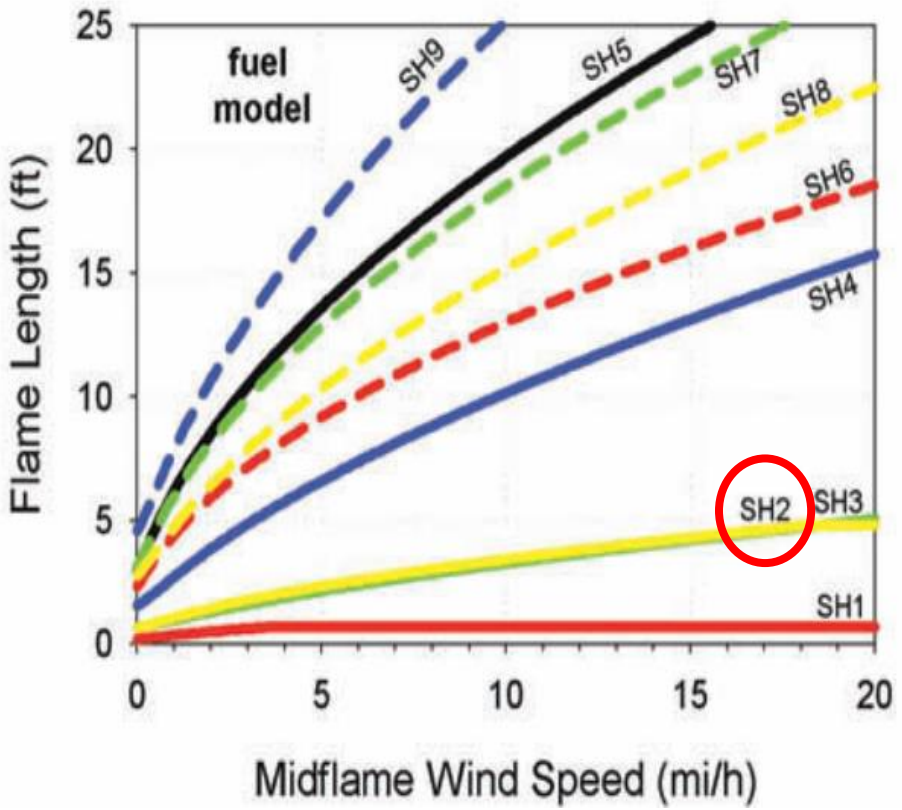
Shrub cover: 37.5%
PG cover: 12.5%
Annual grass cover: 2.5%
Bare soil cover: 12.5%



SH2 – Moderate load, dry climate shrub

- Relative to SH1, shrubs are taller (60-120 cm), canopy connectivity greater, capacity to support fire spread greater (but not by much).





Figures: Expected fire behavior of each of the FBFMs described by Scott and Burgan (2005; reproduced here) as modeled by the fire simulation software "Behave+".

SH2: Example 1

CIRO_3_23

Shrubs are 60-120 cm tall with considerable canopy overlap. Understory consists of sparse Herbaceous fuels, bare ground, and shrub litter.

Shrub cover: 65%
PG cover: 17.5%
Annual grass cover: 0%
Bare soil cover: 7.5%

SH2: Example 2

Shrubs are 60-120 cm tall with considerable canopy overlap.

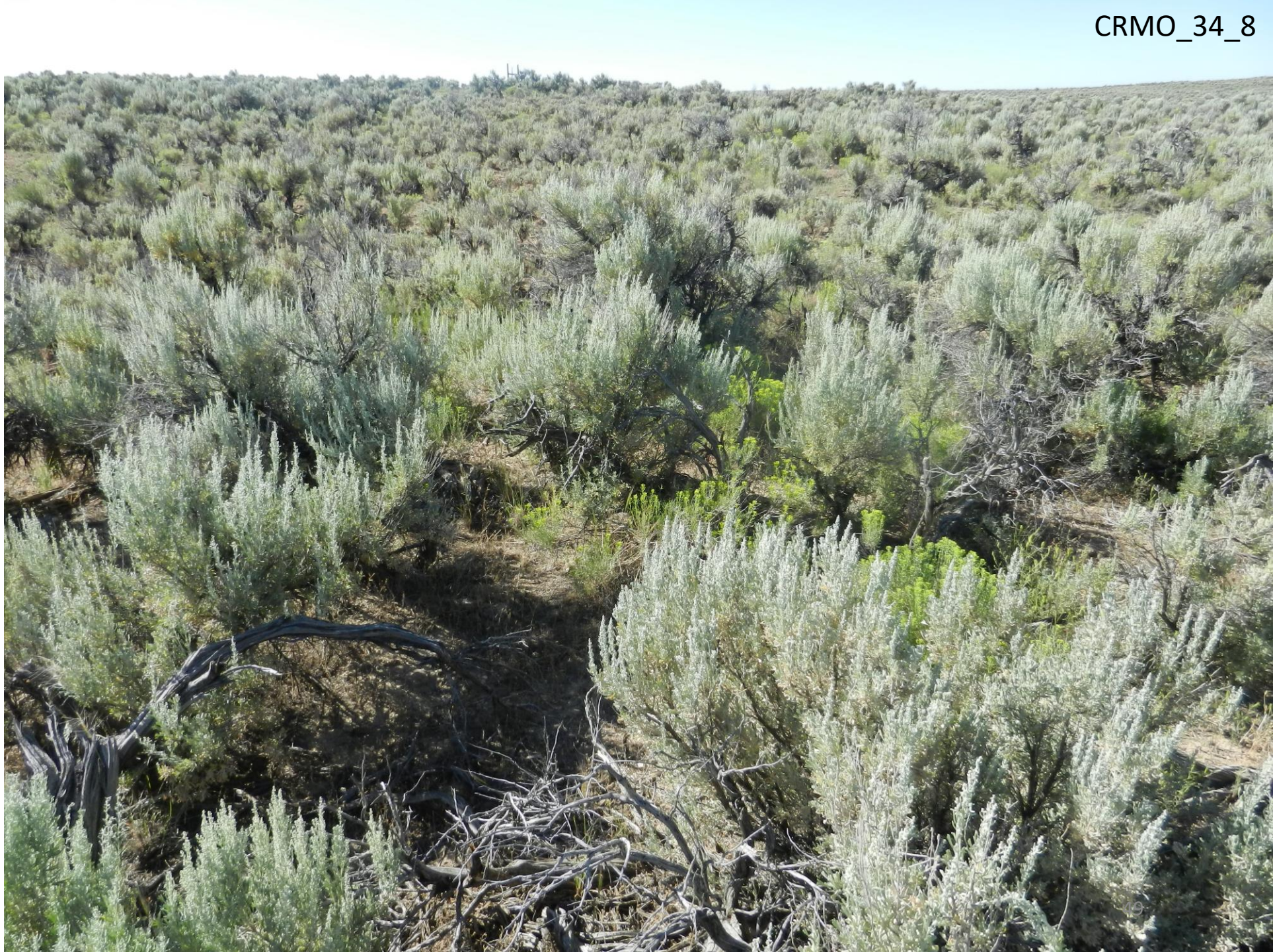
Grass fuels and bare ground are sparse. Understory dominated by shrub litter.

Shrub cover: 75%
PG cover: 3%
Annual grass cover: 2.5%
Bare soil cover: 17.5%

SH2: Example 3

CRMO_34_8

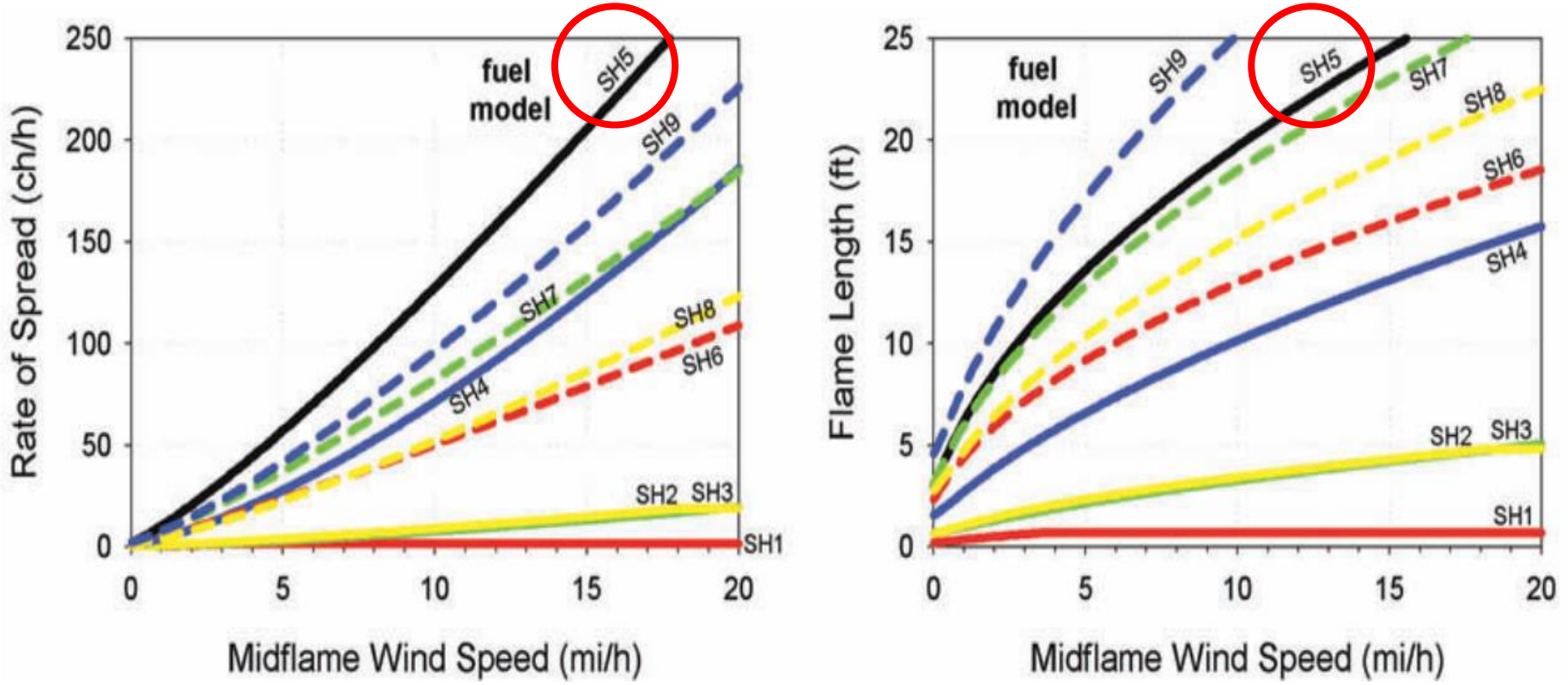
Shrubs are 60-120 cm tall with considerable canopy overlap. Herbaceous fuels are sparse. Understory dominated by bare ground and shrub litter.



Shrub cover: 65%
PG cover: 3%
Annual grass cover: 0.5%
Bare soil cover: 12.5%

SH5 – High load, dry climate shrub

- Tall shrubs (> 120 cm) with high canopy connectivity and moderate to high amounts of shrub and herb litter in the understory. These fuel beds will be extremely difficult to walk through.



Figures: Expected fire behavior of each of the FBFMs described by Scott and Burgan (2005; reproduced here) as modeled by the fire simulation software "Behave+".

SH5: Example 1

CIRO_6_8

Shrubs are > 120 cm tall with considerable canopy overlap. Understory consist of short herbaceous fuels.

Shrub cover: 45%
PG cover: 7.5%
EAG cover: 12.5%
Bare soil cover: 7.5%

SH5: Example 2

CRMO_29_23

Shrubs are >120 cm tall and dense. Understory consist of short (< 30 cm), annual grasses.

Shrub cover: 45%
PG cover: 3%
Annual grass cover: 12.5%
Bare soil cover: 3%

SH5: Example 3

Shrubs are > 120 cm tall and dense. Understory dominated by shrub litter.

Shrub cover: 65%
PG cover: 0.5%
Annual grass cover: 0%
Bare soil cover: 1%

SH5: Example 4

CIRO_3_11

Shrubs are > 120 cm tall with considerable canopy overlap. Understory consist of sparse perennial grasses and shrub litter.

Shrub cover: 65%
PG cover: 12.5%
Annual grass cover: 0%
Bare soil cover: 17.5%

Literature cited

- Anderson, H.E., 1982. Aids to determining fuel models for estimating fire behavior (Vol. 122). US Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station.
- Bates, J., Johnson, D., Davies, K.W., Svejcar, T. and Hardegree, S., 2023. Effects of annual weather variation on peak herbaceous yield date in sagebrush steppe. Western North American Naturalist, 83(2), pp.220-231.
- Bourne, A. and Bunting, S.C., 2011. Guide for quantifying post-treatment fuels in the sagebrush steppe and juniper woodlands of the Great Basin.
- Scott, J.H., Burgan, R.E., 2005. Standard fire behavior fuel models: a comprehensive set for use with Rothermel's surface fire spread model. Gen. Tech. Rep. RMRS-GTR-153. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 72 p.
- Shinneman, D.J., Welty, J.L., Arkle, R.S., Pilliod, D.S., Glenn, N.F., McIlroy, S.K. and Halford, A.S., 2018. Fuels guide and database for intact and invaded big sagebrush (Artemisia tridentata) ecological sites—User manual (No. 1048). US Geological Survey.

Acknowledgments

Funding was provided by the USGS Land Management Research Program and Bureau of Land Management (Sagebrush Ecosystem and Rangeland Fire Projects #120, #215), US Fish and Wildlife Service, and USGS National Resources Preservation Program in support of National Park Service information needs. Special thanks to Michele Crist o the BLM, Jason Pyron of FWS, and Tom Rodhouse of NPS for making the funding opportunities available. Doug Shinneman and Scott Schaff provided helpful peer review comments which improved the field guide. Genie Montblanc and the Great Basin Fire Science Exchange helped in disseminating this guide. The following USGS FIREss staff helped the project or collected supporting information: Bill Davidson, Matt Fisk, Krystal Busby, Kyle Calf-Looking, Destiny Begin, Whitney Moore, Rebecca Donaldson, Logan Brauer, Haley Disinger, Sydnee Dunn, Jenn Butt, Hunter Moore, Aliya Brown, Calene Thomas, Dani Laird, Darius Liles, Andrew Lague, Katie Bush, Fisher Corbin, Max Miley, Chloe Watt, and Austin Davis. Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the US Government.

USGS science for a changing world

FIREss: Fire, Invasives, and Restoration Ecology of Sagebrush Steppe

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF LAND MANAGEMENT