The Rangeland Vegetation Simulator: A system for quantifying production, succession, disturbance and fuels in non-forest environments Paulette Ford¹ Matt Reeves¹ Leonardo Frid² VSDA Forest Service, Rocky Mountain Research Station

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Introduction

Rangeland landscapes occupy roughly 662 million acres in the coterminous U.S. and their vegetation responds quickly to climate and management, with high relative growth rates and extreme inter-annual variability. Current national decision support systems in the U.S. such as the Interagency Fuels Treatment Decision Support System (IFT-DSS) require spatially explicit information describing production, fuels, grazing capacity and successional trajectory. Therefore a system is needed that quantifies these vegetation and fuel characteristics to permit estimations of annual production, grazing capacity, and fire behavior and effects. This situation inspired our project to develop a program for simulating succession, productivity, and fuels in non-forest environments. This system is called the Rangeland Vegetation Simulator (RVS).

Materials and Methods





What Do I need to run RVS?

- User has control over inputs
- Plot location
- Species composition
- Relative cover
- Climatology
- Treatment information
- If you don't have these data then use RVS data loader



Can be coupled with ST-SIM

- RVS is an open source C++ library written for multi-platform deployment
- The code is hosted on Github at <u>https://github.com/rlank/RVS</u>
- RVS can run 1500 plots for 50 years each on a mid-range desktop in about 30 seconds

Results and Discussion

Fuels

- 1, 10, 100, 1000 hr fuels
- Surface fire behavior fuel models
- Fuel loading models
- Fuel Characteristic Classification System





Current Applications Quantifying trends in forage in California grazing allotments

Vegetation

- Annual yield, standing crop
- Shrub and herb cover and height
- Stems per acre, various allometric components
- Effects of herbivory and fire on succession,

fuels and biomass

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ion 'RVS' (2 projects) 🛛 🔺		
olution Items		<pre>val = record->requestValue(paranNames[i]);</pre>
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B BiomassDIO.h	#include "Disturbance/DisturbanceDD.h"	return biomass;
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B BiomassDriver.h		
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B BiomassEqDriver.h	using namespace RVS;	
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B AnalysisPlot.h	<pre>const char* DEBUG_FILE = "RVS_Debug.txt";</pre>	
8 *+ DataTable.cpp		
B DataTable.h	<pre>bool* USE_MEM = new bool(true);</pre>	<pre>equationNumber = bdio->query_crosswalk_table(BIGMASS_BACKUP_SPP_CODE, STEMS_PER_ACRE_EQUATION_FIELD);</pre>
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B*+ DisturbAction.cpp	<pre>void fiveYearHerbTest(int year, RVS::DataManagement::AnalysisPlot* currentPlot,</pre>	
B DisturbAction.h	Biomass::BiomassDriver* bd,	<pre>double singleStem = BiomassEquations::eq_PCH(coefs[0], coefs[1], record->HEIGHT());</pre>
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B DisturbanceDriver.h	<pre>woid shrublauationTest();</pre>	
External Dependencies		
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B FuelsDIO.h	Biomass::BiomassDriver* bd,	
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FuelsEquations.cpp		
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Header Files		
✓ B RVSDBNAMES.h		
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B sqlite3.h		
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B SuccessionDIO.h	'librys.exe' (Win32): Loaded 'C:\Windows\System32\msvcr128d.dll', Cannot find or open the PDB file.	
#++ SuccessionDriver.cpp	'librvs.exe' (Win32): Loaded 'C:\Windows\System32\msvcp120d.dll'. Cannot find or open the POB file.	
B SuccessionDriver.h	The program '[4020] librvs.exe' has exited with code 0 (0x0).	
External Dependencies		

Implications: So What?

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_Group_Covariance_Cross	4			Click here	e to define a fi	ilter											
Group_LUT3	> 1 EOSG 02	11250 Inter-Mountain Basins Big Sagebrush Steppe	911250	30	0.9	27.43	405	44.254472	-117.343389	222.46	304.24	334.19	413.86	562.08	3213	3672	413
S Fuelmodels	2 EOSG 04	11250 Inter-Mountain Basins Big Sagebrush Steppe	911250	10	1.8	54.86	332	44.273028	-117.219972	185.29	267.9	302.47	370.94	536.66	3935	4228.5	452
S_Growth_Rates	3 EOSG 05	11250 Inter-Mountain Basins Big Sagebrush Steppe	911250	33	1.1	33.53	450	42.96925	-119.908194	162.26	245.66	305.21	382.33	493.36	3182	3604	402
S_Master	4 EOSG 06	10790 Great Basin Xeric Mixed Sagebrush Shrubland	910790	9	0.9	27.43	2184	42.926139	-119.963778	170.07	251.52	311.06	391.62	503.57	3137	3683	422
variance_Matrix	5 EOSG 07	11250 Inter-Mountain Basins Big Sagebrush Steppe	911250	9	1.2	36.58	450	42.971278	-119.913083	162.26	245.66	305.21	382.33	493.36	3231	3583	393
variance_Matrix_NoGroup	6 EOSG 09	11250 Inter-Mountain Basins Big Sagebrush Steppe	911250	5	1.4	42.67	2183	42.329528	-119.410056	177.52	235.25	274.27	340.68	462.82	2447	2728	300
sturbance	7 EOSG 10	11250 Inter-Mountain Basins Big Sagebrush Steppe	911250	5	1.5	45.72	2183	42.368722	-119.400639	171.23	231.98	267.58	332.08	452.13	2135	2363.5	259
sturbance_Plots	8 EOSG 11	11260 Inter-Mountain Basins Montane Sagebrush Steppe	911260	11	1.5	45.72	2183	42.364361	-119.353528	234.78	296.39	352.05	446.14	575.01	3312	3786	426
sturbance_Plots_NoFire	9 EOSG 12	11260 Inter-Mountain Basins Montane Sagebrush Steppe	911260	5	1.2	36.58	2183	42.317444	-119.350667	221.94	281.8	334.46	423.02	551.27	3524	4009	449
	10 SG 01	11410 Northwestern Great Plains Mixedgrass Prairie	2011410	10	0.5	15.24	140	47.538	-108.87825	249.27	290.53	331.16	388.69	475.61	2828	3632.5	443
T	11 SG 02	11410 Northwestern Great Plains Mixedgrass Prairie	2011410	16	1.1	33.53	140	47.62875	-108.625972	251.92	290.15	333.48	399.04	500.49	4147	4558.5	497
el Class GrassTyne	12 SG 03	11410 Northwestern Great Plains Mixedgrass Prairie	2011410	6	0.4	12.19	140	47.537917	-108.878222	249.27	290.53	331.16	388.69	475.61	2828	3632.5	443
el Class MixedType	13 SG 04	11410 Northwestern Great Plains Mixedgrass Prairie	2011410	74	1.2	36.58	140	47.635889	-108.667167	255.41	292.82	333.68	399.11	508.76	4088	4584	508
el Class ShrubType	15 SG 05	11410 Northwestern Great Plains Mixedgrass Prairie	2011410	8	0.6	18.29	140	47.529333	-108.875889	249.27	290.53	331.16	388.69	475.61	4980	5326.5	567
el_ClassRules	16 SG 06	11410 Northwestern Great Plains Mixedgrass Prairie	2011410	8	0.6	18.29	140	47.550389	-108.830083	251.26	289.52	332.49	388.7	481.88	4671	5256.5	584
el_Crosswalk	17 SG 07	11410 Northwestern Great Plains Mixedgrass Prairie	2011410	49	1.4	42.67	140	47.629861	-108.623222	251.92	290.15	333.48	399.04	500.49	3768	4166	456
el_Equation	18 SG 08	10540 Southern Rocky Mountain Ponderosa Pine Woodland	2010540	53	0.9	27.43	140	47.550167	-108.829583	251.26	289.52	332.49	388.7	481.88	4671	5256.5	584
rb_Growth	19 56 09	11260 Inter-Mountain Basins Montane Sagebrush Steppe	1911260	37	0.5	15.24	3/4	44.910278	-113.354.906	460.14	503.21	573.53	637.79	760.8	4955	5408.5	586
ants	20 56 10	11200 Inter-Mountain Basins Montane Sagebrush Steppe	1911260	23	0.5	15.24	3/4	44.910944	-113.350528	372.58	411.27	409.83	531.98	035.32	52/0	5522	5/6
ots_Blind	21 56 11	11200 Inter-Mountain Basins Montane Sagebrush Steppe	1911260	25	0.4	12.19	342	45.313889	-113.027639	515.68	583.52	644.43	704.63	838.85	5679	6083	648
ots_FCCS	22 SWSB 01	11550 Inter-Mountain Basins Greasewood Flat	1711530	2	0.6	18.29	(null)	40.941908	-114.957858	141./3	195.88	229.8	280,89	409.90	1/54	1995	223
LASS	23 SWSB 02	10790 Great Basin Xeric Mixed Sagebrush Shrubland	1210790	2	1	20.49	(null)	40.94365	-114.304631	249.41	220.66	233,82	266.25	\$64.00	2592	2004	211
rubs_blind	24 54458 03	10900 Jates Mountain Rasins Rig Sagebrush Shouhland	1210900	19	1	30,48	(null)	41.127919	-113.7493331	162.42	214.76	252.20	202.42	492.97	2302	2444	260
lubs_rees	25 STAISE OF	10000 Inter-Mountain Dasins Big Sagebrush Shoubland	1210800	25	0.0	24.29	(mull)	41 124542	114.070279	162.42	214.76	252.20	202.42	403.07	2221	2746	203
t herb test	20 54458 05	10700 Great Basin Veris Mixed Sagebrush Shrubland	1210300	25	0.5	15.24	(null)	41.134342	-115 700056	245 20	276.23	209.62	362.62	559.09	2521	2092.5	252
omass Output	28 SWSB 07	10790 Great Basin Xeric Mixed Sagebrush Shrubland	1210790	27	0.6	18 29	(null)	41 123142	-115 737864	248.41	278.40	312 71	366 35	564.00	2831	3411	300
omass_Output_Spp	29 SWSB 08	10800 Inter-Mountain Basins Big Sagebrush Shrubland	1210800	84	0.8	24.38	(null)	40.780519	-116.07225	182.53	205.98	243.38	277.44	444.51	2432	3040	364
els_Output	30 SWSB 09	10790 Great Basin Xeric Mixed Sagebrush Shruhland	1210790	20	0.9	27.43	(null)	41 141047	-115 667478	249.95	279.96	313.86	368.45	566.88	3227	3530.5	383
ccession_Output	31 SWSB 10	10790 Great Basin Xeric Mixed Sagebrush Shrubland	1210790	15	0.6	18.29	(null)	41.144764	-115.673683	249.95	279.96	313.86	368.45	566.88	3424	3794.5	416
it_FCCS_test	32 SWSB 11	10790 Great Basin Xeric Mixed Sagebrush Shrubland	1210790	23	0.8	24.38	(null)	41.145756	-115.679714	249.95	279.96	313.86	368,45	566.88	3580	4082	458
omass_Output	33 MCS 01	10270 Mediterranean California Dry-Mesic Mixed Conifer Forest and Woodland	310270	12	1	30.48	(null)	42.262619	-123.064853	355	539	619.85	714.6	1103.24	7036	7238.5	744
omass_Output_Spp	35 MCS 03	10280 Mediterranean California Mesic Mixed Conifer Forest and Woodland	310280	64	0.6	18.29	(null)	42.096653	-123.638767	952.64	1308.67	1496.45	1984.38	2585.27	6032	6631	723
els_Output	36 MCS 04	10280 Mediterranean California Mesic Mixed Conifer Forest and Woodland	310280	21	0.7	21.34	(null)	42.096828	-123.638686	952.64	1308.67	1496.45	1984.38	2585.27	7014	7214	741
ccession_Output	44 EOSJ 01	10790 Great Basin Xeric Mixed Sagebrush Shrubland	910790	4	0.9	27.43	(null)	42.901694	-119.92025	174.27	254.34	317.44	398.03	507.63	3168	3547.5	392
	45 EOSJ 02	10790 Great Basin Xeric Mixed Sagebrush Shrubland	910790	3	1.1	33.53	(null)	42.915889	-119.962694	170.07	251.52	311.06	391.62	503.57	3116	3405.5	369
	46 EOSJ 03	11250 Inter-Mountain Basins Big Sagebrush Steppe	911250	3	0.7	21.34	(null)	42.913167	-119.928417	174.27	254.34	317.44	398.03	507.63	4314	4544.5	477
	47 EOSP 01	11540 Inter-Mountain Basins Montane Riparian Systems	711540	29	1.4	42.67	(null)	43.938167	-121.199361	195.72	292.03	328.06	421.72	552.77	2580	3103	362
	48 EOSP 02	10532 Northern Rocky Mountain Ponderosa Pine Woodland and Savanna - Xeric	710532	16	2	60.96	(null)	43.5735	-120.921556	162.64	265.65	309.01	368.52	503.83	4864	5261	565
	49 EOSP 03	11650 Northern Rocky Mountain Foothill Conifer Wooded Steppe	711650	18	1	30.48	(null)	43.5155	-121.021083	149.67	238.76	289.68	336.26	462.67	4403	4745	508
	50 EOSP 04	10532 Northern Rocky Mountain Ponderosa Pine Woodland and Savanna - Xeric	710532	21	1.8	54.86	(null)	43.590278	-120.815028	155.75	254.92	297.34	364.13	483.82	4757	5072	538
	51 EOSP 05	10531 Northern Rocky Mountain Ponderosa Pine Woodland and Savanna - Mesic	710531	14	0.8	24.38	(null)	43.52775	-121.017361	151.79	246.62	297.08	341.89	473.86	4740	5139	553
	52 OJW 01	10230 Madrean Encinal	2510230	17	1.2	36.58	(null)	31.481333	-110.343583	284.6	390.82	493.53	601.4	807.56	4900	5253	560
	53 OJW 02	10770 Chihuahuan Succulent Desert Scrub	2510770	21	1	30,48	(null)	31.526583	-108.977806	224.64	328.69	408.19	479.62	635.67	3319	4137	495

- Estimating above ground carbon in the intermountain Region (supporting Forest Plan Revision)
- Quantifying future range of variability in FS lands in New Mexico under varying climates
- Quantifying post-fire vegetation recovery for improving grazing

management guidelines



3,500.00 3,000.00 2,500.00 2,000.00 1,500.00 1,000.00 500.00

	ha				
nta-Wasatch-Cache National Forest	280,720	6.48	5.06	3.63	
ise National Forest	179,803	3.89	2.67	1.61	
ribou-Targhee National Forest	341,063	3.08	2.35	1.52	
shlake National Forest	140,290	10.55	9.62	8.91	
hley National Forest	125,121	4.80	4.08	3.60	
mboldt-Toiyabe National Forest	1,256,071	7.48	6.16	5.26	
wtooth National Forest	381,122	5.38	4.49	3.25	
Imon-Challis National Forest	357,765	3.19	2.10	1.03	
yette National Forest	36,791	2.72	1.90	1.09	
xie National Forest	114,065	13.33	12.45	11.75	
idger-Teton National Forest	362,678	1.38	1.19	0.61	
anti-La Sal National Forest	111,428	7.27	6.46	5.83	



Albuquerque Interannual Variability Phoenix 0 Signa 8% 9% - 12% 13% - 14% 15% - 17% 18% - 20%

Acknowledgements

We acknowledge the Joint Fire Sciences Program for providing initial development of the RVS and the National Fire Plan.

Lice RV/S to monitor annual production

- Use RVS to monitor annual production
- Useful for understanding links between climate, management, site production, and fuels
- Use RVS to quantify how your management will change fuel and fire behavior
- Use RVS to project implications of prescribed grazing
- Use RVS to identify areas of strength and weakness in your grass-bank
- Use RVS to prioritize restoration resources

Risk management!