

Phenology Model Development Spreadsheet for Fenders Blue Butterfly

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Color codes

suspicious data

current model

final parameters

Methods: Fit model to field data using lowest error rates (CV)

During the analysis, it was noted that Fern Ridge was consistently early compared to other sites, so a separate model was eventually fitted to Fern Ridge.

Table 1. Field Data:				Elev.	Estimated Peak Flight Dates					Notes:
Site	County	Latitude	Longitude	(ft.)	2006	2007	2009	2010	2011	
Oak Ridge	Yamhill	45.34693	123.28260	850		5/22	5/26	6/6	Jun14to21	
Gopher Valley	Yamhill	45.18052	123.37183	400		May 20-25	May 25-30	June 5-13	Jun17to21	
Mill Creek	Polk	45.02228	123.42560	400		5/20		5/29	NA	
Baskett Butte	Polk	44.96285	123.26223	400		5/18	5/22	5/30	Jun4to7	
Pearcy (Wren)	Benton	44.59107	123.40873	450		5/18	5/24	5/30	Jun12to14	
McDonald Forest	Benton	44.62473	123.35512	1800		5/30	5/29	6/10	06/27/11	
Lupine Meadows	Benton	44.55448	123.35450	360		5/22	5/24	5/29	Jun12to14	
Fern Ridge	Lane	44.09863	123.26595	380	5/17	5/11	5/21	5/14	NA	← Earlier flight than at other locales
Willow Creek	Lane	44.03252	123.16677	420	5/19	5/17	5/27	5/27	Jun9to15	
					Estimated First Flight Dates					
Baskett Butte									05/19/11	
Pearcy (Wren)									05/24/11	
Lupine Meadows									05/29/11	
Fern Ridge					5/3	4/27	5/7	5/1	05/12/11	← Earlier flight than at other locales
Willow Creek					5/5	5/10	5/17	5/13		

Collaborators include: U.S. Fish and Wildlife Service, Benton county, The Xerces Society, The U.S. Army Corp of Engineers, The Bureau of Land Management, and the Nature Conservancy

Table 2. Peak Flight Lowest C. V. determination of Lower Threshold (first vary Tlow, then start date; some preliminary data not shown)

Site	County	Nearest available weather station	Date Observed	Feb 1 start			Mar 1 start		Feb 15 start	Jan 15 start	
				average	Dds	Dds	Dds	Dds			
				Tlow 41	Tlow 40	Tlow 42	Tlow 41	Tlow 39	Tlow 41	Tlow 41	
Lupine Meadows	Benton	FNWO3	06/13/11	1036	1139	937	950	1248	966	1132	
			05/29/10	961	1058	867	786	1159	876	1045	
			note some ba	05/24/09	844	926	766	753	1012	811	861
			Jan data 200	05/22/07	960	1048	876	843	1140	895	989
Baskett Butte	Polk	CRVO	06/05/11	898	996	806	824	1098	837	980	
			05/30/10	966	1066	871	793	1069	890	1054	
			05/22/09	775	859	696	680	946	741	792	
			05/18/07	891	978	808	765	1069	820	918	
Pearcy (Wren)	Benton	CRVO	06/13/11	1029	1134	928	954	1245	967	1110	
			05/30/10	966	1066	871	793	1069	890	1054	
			05/24/09	804	889	723	709	978	769	820	
			05/18/07	891	978	808	765	1069	820	918	
Gopher Valley	Yamhill	MWDO3	06/19/11	993	1102	889	927	1217	937	1056	
			06/06/10	1061	1172	954	900	1286	995	1151	
			05/28/09	910	996	828	817	1086	876	942	
			05/21/07								
Willow Creek	Lane	HBFO3	06/12/11	1071	1175	972	974	1284	992	1180	
			05/27/10	995	1091	904	801	1190	906	1095	
			05/27/09	905	991	824	800	1080	863	921	
			05/17/07	934	1017	854	803	1104	857	977	
			05/19/06	909	990	833	788	1074	830	970	
Fern Ridge	Lane	HBFO3	NA	HBFO3	HBFO3	HBFO3	HBFO3	HBFO3	HBFO3	HBFO3	
			05/14/10	825	908	745	631	994	735	924	
			05/21/09	801	881	725	696	964	759	817	
			05/11/07	853	931	780	723	1012	776	896	
			05/17/06	861	939	786	740	1021	781	922	
	W/O Fern Ridge:	mean		939.95	1033.55	850.75	821.25	1121.15	876.9	998.25	
		st dev		80	88.02	72.35	80.82	97.54	70.22	108.74	
		CV		8.51	8.52	8.5	9.84	8.7	8.01	10.89	
		W/Fern Ridge:	mean		922.46	1013.75	835.46	800.63	1100.58	857.88	980.17
st dev		83.55	92.38	75.19	88.96	100.75	77.58	108.64			
CV		9.06	9.11	9	11.11	9.15	9.04	11.08			

Fern Ridge only:	mean	835	914.75	759	697.5	997.75	762.75	889.75
	st dev	27.42	26.06	28.99	47.89	25.14	20.76	50.15
	CV	3.28	2.85	3.82	6.87	2.52	2.72	5.64

Narrative: Peak flight w/lowest CV occurred with Tlow=41F, start date=Feb 15, at 858 DD including the much earlier than average Fern Ridge site if Fern Ridge is excluded from the analysis, the average DD to peak flight is 877 DD, 19 DD later. A peak flight model for Fern Ridge alone would be 763 DD, or 95 DD earlier than the overall average peak flight time and 114 DD earlier than the average of all non-Fern Ridge sites.

Table 3. First Flight Lowest C. V. determination of Lower Threshold

Site	County	Nearest avail. weather sta.	Date	Observer	Mar 1 Start	Mar 1 Start	Feb 15 st	Feb 15 st	Virtual
					Act. Station	Virt. Station	Act. Station	Virt. Station	
Lupine Meadows	Benton	FNWO3	05/29/11		41	41	41	41	weather sta.
Baskett Butte	Polk	CRVO	05/19/11		695	688	711	705	v2my152
Pearcy (Wren)	Benton	CRVO	05/24/11		585	530	598	563	v2my155
Gopher Valley	Yamhill	MWDO3	NA		639	613	667	628	v2my154
Willow Creek	Lane	HBFO3	NA						
			05/13/10		612	579	716	679	v2my167
			05/17/09		638		700		
			05/10/07		711		765		
			05/05/06		545		587		
Fern Ridge	Lane	HBFO3	05/12/11		537	515	555	530	
			05/01/10		482	488	587	556	v2my166
			05/07/09		504		567		
			04/27/07		545		598		
			05/03/06		511		553		
W/O Fern Ridge:			mean		632.14	602.5	677.71	643.75	
			st dev		58.41	66.41	65.05	62.62	
			CV		9.24	11.02	9.6	9.73	
W/Fern Ridge:			mean		583.67	568.83	633.67	610.17	
			st dev		75.41	73.75	73.58	71.6	
			CV		12.92	12.97	11.61	11.73	
Fern Ridge only:			mean		515.8	501.5	572	543	
			st dev		25.53	19.09	19.85	18.38	
			CV		4.95	3.81	3.47	3.39	

Narrative: Peak flight w/lowest CV occurred with Tlow=41F, start date=Feb 15, at 634 DD including the much earlier than average Fern Ridge site if Fern Ridge is excluded from the analysis, the average DD to peak flight is 678 DD, 44 DD later. A peak flight model for Fern Ridge alone would be 572 DD, or 62 DD earlier than the overall average peak flight time and 106 DD earlier than the average of all non-Fern Ridge sites.

Table 4. 2011 Model Predictions with virtual stations and Difference vs. Observations (using combined model)

Location	Virtual Sta. Code	Elevation (ft)	Pred 1 st flt	Obs. 1 st flt	Diff (days)	Abs Diff (days)	Pred Peak flt	Obs. Peak flt	Diff (days)	Abs Diff (days)	notes:
Lupine Meadows	v2my152	337	05/22/11	05/29/11	7	7	06/08/11	06/13/11	5	5	
Baskett Butte	v2my155	321	05/28/11	05/19/11	-9	9	06/12/11	06/06/11	-6	6	
Pearcy (Wren)	v2my154	439	05/25/11	05/24/11	-1	1	06/10/11	06/13/11	3	3	
Oak Ridge	v2my156	816	06/10/11	NA			06/25/11	06/18/11	-7	7	
McDonald Forest	v2my153	1712	06/12/11	NA			06/26/11	06/27/11	1	1	
Gopher Valley	v2my157	383	05/23/11	NA			06/10/11	06/19/11	9	9	
Mill Creek	v2my158	390	06/03/11	NA			06/15/11	NA			
Willow Creek	v2my167	419	05/20/11	NA			06/06/11	06/12/11	6	6	
Fern Ridge	v2my166	380	05/20/11	05/12/11	-8	8	06/06/11	NA			
		Mean	05/29/11	05/24/11	-1.00	5.67	06/14/11	06/15/11	1.57	5.29	
		St Dev	8.83	5	8	4.16	7.58	6.65	6.05	2.63	

Table 5. Additional Checks using nearest observing weather stations rather than virtual weather

Location	Virtual Sta. Code	Elevation (ft)	Pred 1 st flt	Obs. 1 st flt	Diff (days)	Abs Diff (days)	Pred Peak flt	Obs. Peak flt	Diff (days)	Abs Diff (days)	notes:
Lupine Meadows	CRVO		05/22/11	05/29/11	7	7	06/07/11	06/13/11	6	6	
Baskett Butte	C5404	292	05/25/11	05/19/11	-6	6	06/10/11	06/06/11	-4	4	Useful station
Pearcy (Wren)	<ORPHILO1	567	05/10/11	05/24/11	14	14	05/25/11	06/13/11	19	19	
Oak Ridge	MWDO3	344	05/31/11	NA			06/14/11	06/18/11	4	4	Useful station
McDonald Forest	AR662	1128	05/30/11	NA			06/13/11	06/27/11	14	14	
Gopher Valley	MWDO3	344	05/31/11	NA			06/14/11	06/19/11	5	5	Useful station
Mill Creek	none										
Willow Creek	HBFO3	426	05/19/11	NA			06/05/11	06/12/11	7	7	very near sample site
Fern Ridge	KEUG	354	05/21/11	05/12/11	-9	9	06/07/11	NA			
		Mean	05/23/11	05/21/11	1.50	9.00	06/08/11	06/15/11	7.29	8.43	
		St Dev	7.75	5	10.15	4.36	6.63	6.65	7.39	5.8	

Table 6. Combined (same DD values for all sites including Fern Ridge) – use virtual or nearest observing weather station; whichever is better

Lupine Meadows	v2my152	337	05/22/11	05/29/11	7	7	06/08/11	06/13/11	5	5	All sites including Fern Ridge use 634 & 858 DD for 1 st and peak flight respectively	
Baskett Butte	C5404	292	05/25/11	05/19/11	-6	6	06/10/11	06/06/11	-4	4		
Pearcy (Wren)	v2my154	439	05/25/11	05/24/11	-1	1	06/10/11	06/13/11	3	3		
Oak Ridge	MWDO3	239		NA			06/14/11	06/18/11	4	4		
McDonald Forest	v2my153	1712		NA			06/26/11	06/27/11	1	1		
Gopher Valley	MWDO3	239		NA			06/14/11	06/19/11	5	5		
Mill Creek	v2my158	390		NA				NA				
Willow Creek	v2my167	419		NA			06/06/11	06/12/11	6	6		
Fern Ridge	v2my166	380	05/20/11	05/12/11	-8	8		NA				<-This site using same DDs as others
		Mean	05/24/11	05/24/11	-2.00	5.50	06/12/11	06/15/11	2.86	4		
		St Dev	1.73	5	6.56	3.21	6.6	6.65	3.44	1.63		
		No. sites	4				7					

Results: 2011 first flight was predicted to average May 29 for the 8 sites excluding Fern Ridge (not shown in table). For the 4 sites where data were Available, 1st flight averaged May 24. Overall predicted 1st flight was ca. 2 days late.

For peak flight, the 2011 predictions were on average 2-3 days early and range from 6 days early to 4 days late. This variation reflects factors such as sampling error, distance to weather stations, peak flight dependency on daytime temperatures and other weather variations.

Table 7. Final (using separate DD values for Fern Ridge vs. all other sites) – use virtual or nearest observing weather station; whichever is better

Location	Virtual Sta. Code	Elevation (ft)	Pred 1 st flt	Obs. 1 st flt	Diff. (days)	Abs Diff (days)	Pred Peak flt	Obs. Peak flt	Diff. (days)	Abs Diff (days)	notes:	
Lupine Meadows	v2my152	337	05/27/11	05/29/11	2	2	06/09/11	06/13/11	4	4	All non-Fern Ridge sites Sites using 678 & 877 DD For 1 st and peak flight respectively	
Baskett Butte	C5404	292	05/30/11	05/19/11	-11	11	06/11/11	06/06/11	-5	5		
Pearcy (Wren)	v2my154	439	05/30/11	05/24/11	-6	6	06/11/11	06/13/11	2	2		
Oak Ridge	MWDO3	239		NA			06/16/11	06/18/11	2	2		
McDonald Forest	v2my153	1712		NA			06/27/11	06/27/11	0	0		
Gopher Valley	MWDO3	239		NA			06/16/11	06/19/11	3	3		
Mill Creek	v2my158	390		NA				NA				
Willow Creek	v2my167	419		NA			06/08/11	06/12/11	4	4		
Fern Ridge	v2my166	380	05/15/11	05/12/11	-3	3		NA				<-This site using 572 & 763 DD
		Mean	05/25/11	05/21/11	-4.50	5.50	06/14/11	06/15/11	1.43	2.86		
		St Dev	1.73	5	6.56	4.51	6.53	6.65	3.15	1.68		
		No. sites	4				7					

Results: Using separate models for Fern Ridge vs. all other sites brings about lower error than using a common model for all sites. Thus the resulting model: 1st flight predicted at 572 DD for Fern Ridge, 678 for all other sites. Peak flight pred. at 763 DD for Fern Ridge, 877 DD for all other sites. The model is new and should be tested with additional observations before it can be considered reliable.