

**M428 - Mathematical Modeling for Secondary Educators
Professor Liz Arnold**

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Thursday, December 14, 2017

Montana Shakespeare in the Parks Summer 2018 Tour Schedule

**Proposed by:
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Introduction

Montana Shakespeare in the Parks is an outreach organization stationed at Montana State University in Bozeman. Each summer, they travel across the state and surrounding areas with the goal of exposing as many people as possible to Shakespeare! The staff at Montana Shakespeare in the Parks (MSIP) have expressed difficulty organizing their summer tour schedule. While some shows will remain the same from previous years, they have requested a proposal for their 2018 tour schedule that will reduce the number of miles they have to drive and still meet their goal of reaching people.

Data

MSIP staff have provided data that includes the full tour schedule for the previous four summers with mileage amounts between cities, as well as attendance, weather, and profit amounts from each visited town for the past two years. As part of the attendance information, the data included not only the number of people in attendance, but also the percentage of the town that was in attendance. Additionally, MSIP requested that the first 5 towns be kept relatively similar to previous years, they are scheduled to be in Bozeman to perform at the Sweet Pea Festival, and Missoula and Big Sky are as close to the end of the season as possible. In the past years, the MSIP staff has been given two days off per month, and they have asked to continue that practice. They also asked that July 4th be one of the days given off.

Assumptions

Beyond the requests from MSIP, we made several assumptions. First, while we were told they have historically kept the season order relatively the same between years, we assumed this was not a requirement and that we could change the order as much as is reasonable for our model. The second assumption was that only one town was visited per day, and only one show was performed per day. The third assumption we made was that we could add and/or remove a few towns to break up long distances or simplify part of the journey.

Model

After looking at the routes MSIP has used in the past, identifying problem areas, and considering every possible route, we have come up with the following tour schedule (Figure 1).

The first 8 shows are at the Montana State University Duck Pond, as always. We kept the next 5 locations in the same order at the same time of year, but added Fort Benton, Cut Bank, and Havre. This helped break up the long distance between Conrad and Malta, and also fixed the route so MSIP would only have to travel to the Hi-Line once. Havre was not previously a town MSIP has visited, but we believe it would be a beneficial addition to the tour schedule, and would help more of the Hi-Line be exposed to Shakespeare.

We also condensed the many back-and-forth trips MSIP has made in the past, and turned them into approximately 4 big loops. These loops are the Hi-Line plus eastern Montana, Southern Idaho and parts of Wyoming that returns to Bozeman for Sweet Pea Festival, Western Montana plus Northern Idaho and Washington, and finishing with a loop around Great Falls to complete the season. This helped to cut down on the many miles MSIP must travel in one summer season.

We removed Worland, WY, because it was a very out-of-the-way town, with a low percentage of attendance in the past, which required travelling on less-than-ideal roads to get there. This smoothed out the Wyoming loop, and cut down on the mileage traveled.

We removed day 2 of Great Falls, and replaced it with Simms, because the MSIP staff told us that Simms had expressed interest in hosting them, and the replacement was their idea.

We also added Kalispell and Trego, for three reasons. First, the MSIP staff told us they would like to return to Kalispell based on lots of interest from people who lived there. Second, the addition of Trego to the route helped break up the group of very long drives along that part of the route. Third, the MSIP staff had mentioned that they don't commonly visit any towns near Kalispell, so we added Trego as another, nearby, location in the Flathead Valley.

The rest of the tour locations we shuffled around, to get them to form smooth, cohesive, loops without all the back-and-forth trips that previous years have had.

Date	Town	Miles traveled from last town (rounded up to nearest mile)	Notes
Wednesday, June 13th	Bozeman (MSU Duck Pond)	0	This color = day off
Thursday, June 14th	Bozeman (MSU Duck Pond)	0	
Friday, June 15th	Bozeman (MSU Duck Pond)	0	
Saturday, June 16th	Bozeman (MSU Duck Pond)	0	
Sunday, June 17th	Stage setup/dress rehearsal		
Monday, June 18th	Stage setup/dress rehearsal		
Tuesday, June 19th	Stage setup/dress rehearsal		
Wednesday, June 20th	Bozeman (MSU Duck Pond)	0	
Thursday, June 21st	Bozeman (MSU Duck Pond)	0	
Friday, June 22nd	Bozeman (MSU Duck Pond)	0	
Saturday, June 23rd	Bozeman (MSU Duck Pond)	0	
Sunday, June 24th	DAY OFF - NO SHOWS		
Monday, June 25th	Hobson-Utica	152	
Tuesday, June 26th	Lewistown	24	
Wednesday, June 27th	Fort Benton	101	
Thursday, June 28th	Conrad	78	
Friday, June 29th	Cut Bank	47	
Saturday, June 30th	Havre	126	
Sunday, July 1st	Malta	89	
Monday, July 2nd	Wolf Point	119	
Tuesday, July 3rd	Sidney	92	
Wednesday, July 4th	DAY OFF - NO SHOWS		
Thursday, July 5th	Beach, ND	68	
Friday, July 6th	Glendive	39	
Saturday, July 7th	Ekalaka	109	
Sunday, July 8th	Miles City	115	
Monday, July 9th	Forsyth	46	
Tuesday, July 10th	Colstrip	36	
Wednesday, July 11th	Birney	52	
Thursday, July 12th	Hardin	86	
Friday, July 13th	Sheridan, WY	85	
Saturday, July 14th	Cody, WY	148	
Sunday, July 15th	Powell, WY	24	
Monday, July 16th	Roundup	147	
Tuesday, July 17th	Billings	50	

Wednesday, July 18th	Billings	0	
Thursday, July 19th	Laurel	19	
Friday, July 20th	Columbus	27	
Saturday, July 21st	Absarokee	14	
Sunday, July 22nd	Red Lodge	34	
Monday, July 23rd	Cooke City-Silver Gate	63	Hwy 212 is closed in the winter so we estimated the distance
Tuesday, July 24th	West Yellowstone	91	
Wednesday, July 25th	Driggs, ID	94	
Thursday, July 26th	Thayne, WY	75	
Friday, July 27th	Pocatello, ID	121	
Saturday, July 28th	Pocatello, ID	0	
Sunday, July 29th	Salmon, ID	211	
Monday, July 30th	Dillon, MT	137	
Tuesday, July 31st	DAY OFF - NO SHOWS		
Wednesday, August 1st	Big Timber	193	
Thursday, August 2nd	Chico Hot Springs	60	
Friday, August 3rd	Bozeman - SWEET PEA	49	SWEET PEA
Saturday, August 4th	DAY OFF - NO SHOWS		SWEET PEA
Sunday, August 5th	Bozeman - SWEET PEA	0	SWEET PEA
Monday, August 6th	Deer Lodge	122	
Tuesday, August 7th	Hamilton	128	
Wednesday, August 8th	Seeley Lake	100	
Thursday, August 9th	Kalispell	92	
Friday, August 10th	Trego	53	
Saturday, August 11th	Eureka	17	
Sunday, August 12th	Libby	69	
Monday, August 13th	Sandpoint, ID	84	
Tuesday, August 14th	DAY OFF - NO SHOWS		
Wednesday, August 15th	Liberty Lake, WA	57	
Thursday, August 16th	Trout Creek	119	
Friday, August 17th	Plains	47	
Saturday, August 18th	Superior	45	
Sunday, August 19th	St. Ignatius	72	
Monday, August 20th	Charlo	15	

Tuesday, August 21th	Missoula	56	
Wednesday, August 22nd	Missoula	0	
Thursday, August 23rd	Anaconda	106	
Friday, August 24th	Butte	24	
Saturday, August 25th	Boulder	40	
Sunday, August 26th	Helena	30	
Monday, August 27th	Helena	0	Start of School
Tuesday, August 28th	DAY OFF - NO SHOWS		
Wednesday, August 29th	Choteau	103	
Thursday, August 30th	Simms	29	
Friday, August 31st	Great Falls	35	
Saturday, September 1st	Townsend	122	
Sunday, September 2nd	Whitehall	56	
Monday, September 3rd	Manhattan	41	Labor Day
Tuesday, September 4th	Belgrade	10	
Wednesday, September 5th	Bozeman	11	
Thursday, September 6th	Big Sky	45	
Friday, September 7th	Livingston	69	78 shows
Saturday, September 8th	Strike - Bozeman	27	

Figure 1: The proposed 2018 tour schedule, with days listed as well as towns visited and mileage from last town.

Results

By rearranging the tour schedule in this way, and making the changes we did, our model has reduced MSIP's overall travel by nearly 2000 miles, as shown in Figure 2.

Total Season Mileage	4818	Compared to	2017 Mileage	7819
Average Mileage between towns	68.82857143	Compared to	2017 Average	124.1111111
Maximum Mileage between 2 towns	211	Compared to	2017 Max Distance	299

Figure 2: The differences in distance traveled from the 2017 season to the proposed 2018 season schedule.

Our proposed route has condensed the average distance between towns from 124 miles in 2017 to 69 miles. The longest distance traveled on our route is 211 miles, compared to 299 miles in 2017. Additionally, on our route, there is only *one* distance over 200 miles, whereas in 2017 there were *seven*.

When the two routes are plotted out side by side (Figures 3 and 4), it is easy to see the difference. Our route is much simpler than past routes, and allows for much less driving time.

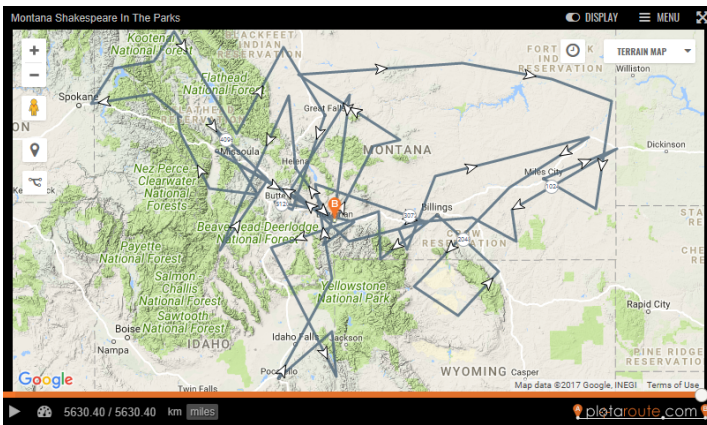


Figure 3: Summer 2017 route

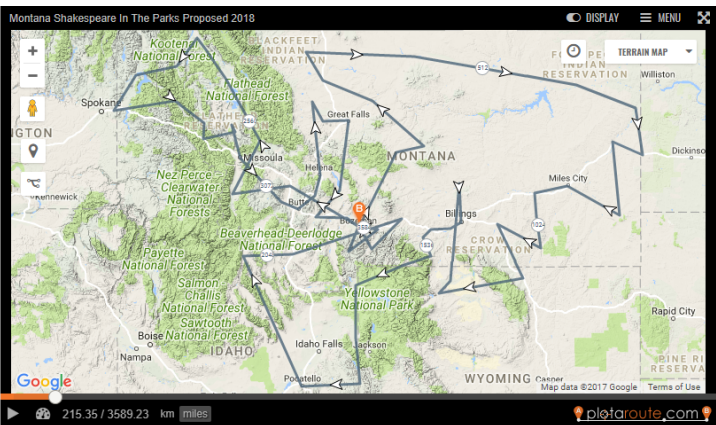


Figure 4: Proposed Summer 2018 route

Limitations

Fire season is an issue faced by Montanans every year, and it can negatively impact the turnout to an MSIP event if the air is filled with smoke. (While every town is required to provide an indoor space as a backup in case MSIP cannot perform outdoors, some of these indoor spaces are not very conducive to an actual performance). Fire season in Summer 2017 started in late July, and went well into October. The Rice Ridge Fire started on July 24, and became a mega-fire on September 3rd. (InciWeb, 2017) This fire caused at least three shows to be hosted in “very smoky” areas, as described by MSIP staff. These shows were in Seeley Lake in late August, and Missoula shows in early September. In order to best avoid smoke-filled air due to wildfires, the tour should start in the most Western areas and work its way Eastward. We did not frame our tour schedule this way, however, because MSIP asked to keep the first 8 days in Bozeman, the next 5 locations (in the Northern part of the state) the same, and to keep Missoula and Big Sky in the last week of the tour.

Another limitation which could pose an issue is that towns must request dates for the MSIP shows. If a town requests a day which does not agree with our schedule, or if our schedule has dates which won’t work for a certain town, then things must be shuffled around to accommodate, which makes for a less efficient tour route. To reduce this issue, MSIP could provide towns with a window during which they can choose a specific day for the show. If this system were to be used, there may be more back-and-forth travel, but instead of traversing across the whole state, it would be contained to a certain smaller area.

Conclusion

Montana Shakespeare in the Parks is a wonderful outreach program which exposes many residents of Montana and the surrounding states to the wonders of Shakespeare. Such cultural enrichment is a valuable resource to future generations of Montanans. In order to reach as many people as possible, MSIP must practice efficiency, frugality, and sustainability. Our proposed tour schedule aims to help in this effort by significantly reducing the mileage driven by MSIP in one summer. By cutting out 2000 miles of driving, MSIP will save nearly \$6000 on fuel, not to mention food and lodging! This is money which could be used to improve and enrich the Shakespeare experience, both for the MSIP staff and for the towns which they visit. By utilising this proposed tour schedule, Montana Shakespeare in the Parks will become even more beneficial than they already are, and Montana as a whole will be better because of it.

References

- "Rice Ridge Fire." *InciWeb - Incident Information System*. InciWeb Developed and Maintained by USDA Forest Service, Fire and Aviation Management, Helpdesk@dms.nwcg.gov. N.p., 4 Oct. 2017. Web. 14 Dec. 2017.
- "Summer Tour." *Montana Shakespeare in the Parks*. Montana State University, 2017. Web. 14 Dec. 2017.

Appendix

Figure 1: The proposed 2018 tour schedule, with days listed as well as towns visited and mileage from last town.

Figure 2: The differences in distance traveled from the 2017 season to the proposed 2018 season schedule.

The following spreadsheet contains the data found in both Figure 1 and Figure 2:

Date	Town	Miles traveled from last town	Notes	Towns we've added	Towns we've removed	Towns in last years schedule	Used in our schedule?
Wednesday, June 13th	Bozeman (MSU Duck Pond)	0	This Color = Days Off	Trego	Worland, WY	Bozeman	y
Thursday, June 14th	Bozeman (MSU Duck Pond)	0		Havre	Great Falls (day 2)	Bozeman	y
Friday, June 15th	Bozeman (MSU Duck Pond)	0		Kalispell		Bozeman	y
Saturday, June 16th	Bozeman (MSU Duck Pond)	0		Simms			y
Sunday, June 17th	Stage setup/dress rehearsal						y
Monday, June 18th	Stage setup/dress rehearsal						y
Tuesday, June 19th	Stage setup/dress rehearsal					Bozeman	y
Wednesday, June 20th	Bozeman (MSU Duck Pond)	0				Bozeman	y
Thursday, June 21st	Bozeman (MSU Duck Pond)	0				Bozeman	y
Friday, June 22nd	Bozeman (MSU Duck Pond)	0				Bozeman	y
Saturday, June 23rd	Bozeman (MSU Duck Pond)	0				Bozeman	y
Sunday, June 24th	DAY OFF - NO SHOWS						y
Monday, June 25th	Hobson-Utica	152				Hobson-Utica	y
Tuesday, June 26th	Lewistown	24				Lewistown	y
Wednesday, June 27th	Fort Benton	101				Conrad	y
Thursday, June 28th	Conrad	78				NEW	y
Friday, June 29th	Cut Bank	47				NEW	y
Saturday, June 30th	Havre	126				Malta	y

Sunday, July 1st	Malta	89				Wolf Point	y
Monday, July 2nd	Wolf Point	119				Sidney	y
Tuesday, July 3rd	Sidney	92				Ekalaka	y
Wednesday, July 4th	DAY OFF - NO SHOWS					Miles City	y
Thursday, July 5th	Beach, ND	68				Beach, ND	y
Friday, July 6th	Glendive	39				Colstrip	y
Saturday, July 7th	Ekalaka	109				Birney	y
Sunday, July 8th	Miles City	115				Hardin	y
Monday, July 9th	Forsyth	46				Columbus	y
Tuesday, July 10th	Colstrip	36				Absarokee	y
Wednesday, July 11th	Birney	52				Red Lodge	y
Thursday, July 12th	Hardin	86				Roundup	y
Friday, July 13th	Sheridan, WY	85				Glendive	y
Saturday, July 14th	Cody, WY	148				Forsyth	y
Sunday, July 15th	Powell, WY	24				Powell, WY	y
Monday, July 16th	Roundup	147				Cody, WY	y
Tuesday, July 17th	Billings	50				Worland, WY	NO
Wednesday, July 18th	Billings	0				Sheridan, WY	y
Thursday, July 19th	Laurel	19				Billings	y
Friday, July 20th	Columbus	27				Billings	y
Saturday, July 21st	Absarokee	14				Silver Gate/Cooke City	y
Sunday, July 22nd	Red Lodge	34				Big Timber	y
Monday, July 23rd	Cooke City-Silver Gate	63	Hwy 212 closed in the winter so we estimated distance			Dillon	y
Tuesday, July 24th	West Yellowstone	91				Thayne WY	y
Wednesday, July 25th	Driggs, ID	94				Driggs ID	y
Thursday, July 26th	Thayne, WY	75				Pocatello ID	y
Friday, July 27th	Pocatello, ID	121				Pocatello ID	y
Saturday, July 28th	Pocatello, ID	0				West Yellowstone	y

Sunday, July 29th	Salmon, ID	211				Townsend	y
Monday, July 30th	Dillon, MT	137				Laurel	y
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Wednesday, August 1st	Big Timber	193				Boulder	y
Thursday, August 2nd	Chico Hot Springs	60				Fort Benton	y
Friday, August 3rd	SWEET PEA	49	SWEET PEA			Sweet Pea	y
Saturday, August 4th	DAY OFF - NO SHOWS		SWEET PEA			DAY OFF	y
Sunday, August 5th	SWEET PEA	0	SWEET PEA			Sweet Pea	y
Monday, August 6th	Deer Lodge	122				Helena	y
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Friday, August 17th	Plains	47				Trout Creek	y
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Friday, August 24th	Butte	24				Great Falls	y
Saturday, August 25th	Boulder	40				Great Falls	NO! - Not wanted

Sunday, August 26th	Helena	30				Whitehall	y
Monday, August 27th	Helena	0	Start of School			Butte	y
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Total Miles Traveled	Total Season Mileage	4818	Compared to	2017 Mileage	7819		
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Figure 3: Summer 2017 route

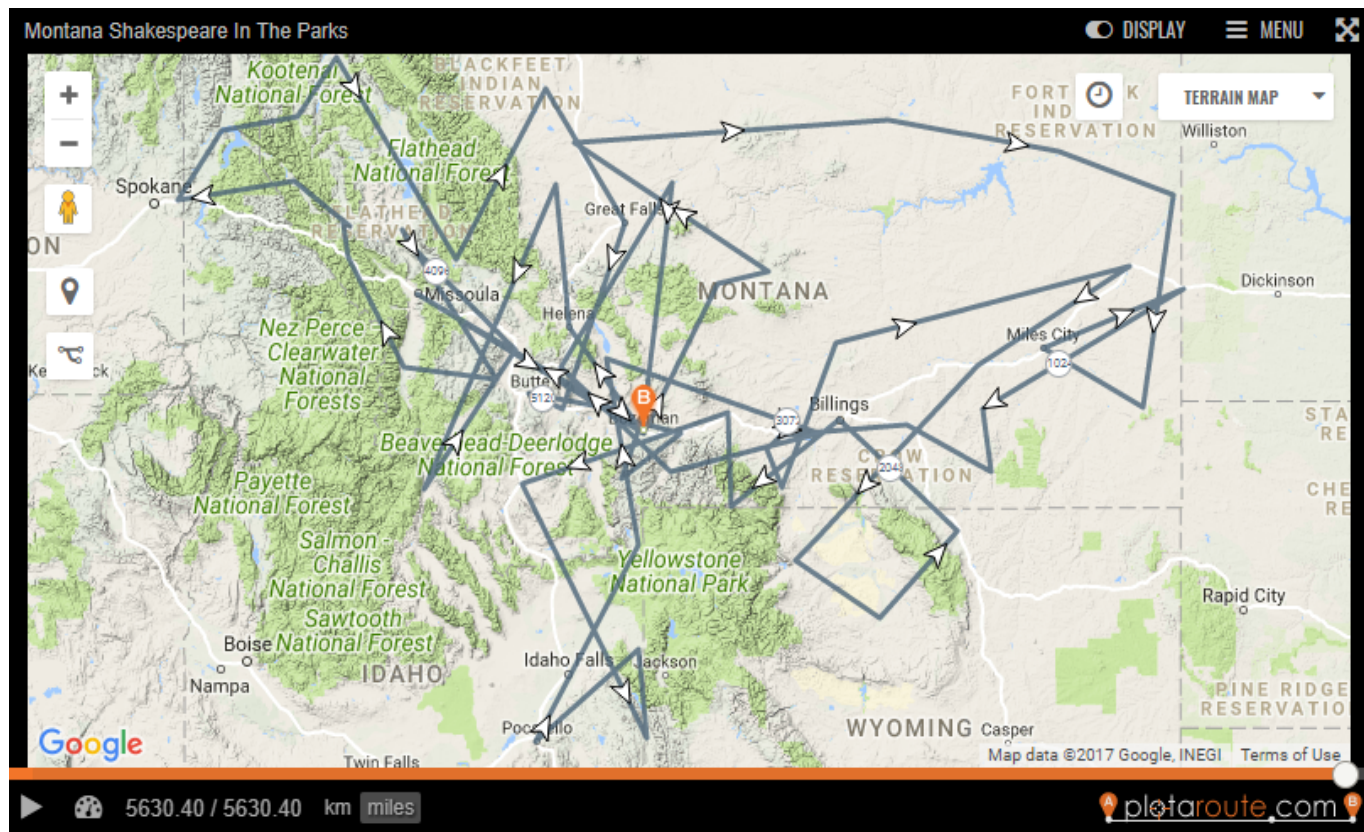


Figure 4: Proposed Summer 2018 route

