

**Operations & Technology Working Group  
Call #6 Meeting Notes (FINAL)**

**TOPIC: BIGFOOT PROJECT**

Call Date & Time: Tuesday, July 1, 2014 at 11 AM

Present:

<b>Name</b>	<b>Affiliation</b>
Bruce Austin	Public
Don Bachman	Public
Kennedy Brown	Two Top
Scott Carsley	Alpen Guides
Bill Howell	Yellowstone Arctic Cat
Ed Klim	ISMA
Alicia Murphy	Yellowstone Nat’l Park
Kim Rapp	Trails Work Consulting
Randy Roberson	Buffalo Bus
Clyde Seely	Three Bear/See Yellowstone
Wade Vagias	Yellowstone Nat’l Park
Travis Watt	Three Bear/See Yellowstone
Jack Welch	Blue Ribbon Coalition

Not Present

<b>Name</b>	<b>Affiliation</b>
Philip Frankovic	Jackson Hole SM Tours
Jason Howell	Yellowstone Arctic Cat
Deborah Mackey	Gardiner Best Western
David McCray	Two Top
Jamie McCray	Two Top
Dan Stusek	Steve Daines’ Office

Review and Approval of Call #5 Notes – Sylvan Pass and OSV Noise Abatement

Don suggested adding the following clarifying text to last month’s notes:

*“The propane devices mentioned are based on detonation of a propane oxygen mixture which provides concussive force and sound impact on the surface of snow avalanche starting zones. The Gazex is a fixed installation which consists of a down pointing “snout” which is constructed so that the controlled detonation is above the snowpack during the course of a winter’s accumulation. These are constructed on each avalanche starting zone of concern.*

*The Daisy Bell is a self-contained device which is slung under a helicopter (wt. about 900#) and is detonated above each starting zone during a flight hover maneuver. These are manufactured in France. In the US, an example of GazEx use is in Teton Pass (WY HY 22) with four installations on and adjacent to the Glory Bowl to mitigate against hazards to about 4,000-6,000 vehicles per-day (VPD). There are other installations on highways in California. The Colorado DOT is constructing an array on the Stanley Slide above HY 40 on Berthoud Pass to protect a corridor with 8,000-12,000 VPD. Daisy Bell is now operational (since 2010) in Little Cottonwood Canyon Utah, Utah HY 210, to supplement protection of this access to Alta and Snowbird with 2,000 – 8000 VPD. Daisy Bell has been acquired by the BNSF Railway to be utilized on their Steven’s Canyon Corridor with 20 – 24 trains per day (on dual tracks) under emergency conditions and only with permission of the Glacier National Park Superintendent per the EIS final rule of 2006.”*

Bruce also clarified that he offered to provide an entire Bombardier snowcoach to Scott Miers, not just an engine.

## Bigfoot Project

### ***Background on the Bigfoot Project:***

- As snowcoaches operating in Yellowstone National Park (YNP) have increased in number, variety of design, and drivetrain configurations, large linear 'ruts' (or troughs) in the snowroads have become a frequent occurrence. These ruts make driving difficult to the detriment of the visitor experience and the health and safety of visitors and administrative personnel.
- To help answer the question of why ruts form, YNP staff initiated a pilot study in winter 2012/2013 to better understand the causes of snowroad rutting. As part of this effort, YNP became interested in discovering if various snowcoach configurations differ in terms of their impacts to snowroads, including those fitted with low-pressure tires. Park staff and concessioners have speculated on the viability of large low pressure tires to access the park in winter; however, a systematic approach to assessing the viability of such vehicles has remained largely untested.
- Three commercial tour operators; Buffalo Bus Touring Company, Xanterra Parks and Resorts, and Scenic Safaris, had previously approached YNP winter use staff inquiring about the park's willingness to experiment with low-pressure tires. Based on these conversations and interest of staff members within YNP, the Park decided to undertake a study in winter 2013/2014 to test the practicality of wheeled snowcoaches using the evaluation criteria described previously.

### ***Four criteria were established in September 2013 to guide the evaluation of this pilot study:***

1. The vehicle must be safe for both the occupants traveling within it and other users of the snowroads in Yellowstone National Park;
2. The vehicle must be no more impactful to resources (including snowroad surfaces, air quality, wildlife, and the natural soundscape) than a comparably-equipped snowcoach on tracks;
3. The vehicle needs to preserve the unique look and feel associated with oversnow wintertime travel in Yellowstone National Park;
4. The vehicle must be able to operate safely and effectively in all weather and snowroad conditions at a level consistent with or greater than a comparably-equipped snowcoach on tracks.

### **Discussion Questions Related to the Bigfoot Project:**

Kim Raap wanted to thank Randy for creating an informative report on the Bigfoot project. He does have several concerns, arising from a history of intense scrutiny over Yellowstone's winter use operations. Since the Bigfoot Project seems that it may be beyond the scope of the SEIS, we need to hold experimental products to scientific protocols. Compared to other monitoring topics, this program seems to be more anecdotal than scientific. It would ultimately be easier to gain approval for the program if science is used early-on in the development process.

- Randy answered that these are good points and that the 1<sup>st</sup> year work went into the design and build of the Bigfoot while data collection was a secondary concern. He did try to send out the Bigfoot with a similarly tracked "sister vehicle" on similar trips to start the comparison process. Next year he plans to have a system to accurately measure MPG and noise emissions for a more scientific comparison.

From Kim via email on 6/24 (formatted by Yellowstone staff into the following questions):

- Is it possible to add MPG data to Figure 6 in order to create a more meaningful comparison with tracked snowcoaches? If one assumes a 61 mile round trip between Randy's shop and Old Faithful, MPG

calculation range from 4.9 to 6.3 mpg. Is there a more accurate way to obtain and clearer way to display this information?

- Wade responded that yes, we can include MPG data and Kim pointed out that more data points equal a better body of science.
- Is there significance to the 42" tire photo? Was anything like this tested?
  - Randy responded that since one of the things we all want is a "unique" look for these snowcoaches, bigger tires are better if they provide good performance. He included the 42" tire in the report for comparison's sake next to 38.5" and 37" tires and Matrax. Although he was not able to test the 42" tire last winter, he has since been able to fit that size tire into the wheelwell and hopes to test both 42" and 44" tires next year. He had to cut into the edge of the door near the gasket to create turning room for the front tires. Randy is going to use a leaf spring and will move the axle 1.5" forward to accommodate the bigger tires. Up to 44" tires are used in other parts of the world, so he is trying to see what works best in Yellowstone.
- Jack asked if Randy had to have a higher lift than with Matrax?
  - Randy replied that yes, there is a 4" lift on traditional Matrax and he will use a 6" lift with the Bigfoot tires, which is easier with the leaf spring.
- Jack asked if the center of the wheel protrudes outwards with these changes to accommodate the brakes.
  - Randy replied that yes they do, but there are fender flare options to reduce snow throw.
- Kim asked if it is possible to create PSI calculations for a comparison between Bigfoot and tracked snowcoaches?
  - Wade said that yes, this calculation is possible and that it could be a meaningful indicator but we don't know for sure at this point.
  - Randy noted that he was very focused on PSI initially, but has found other variables to be as or more important. For example, the diameter of road wheels on tracks makes a big difference as it relates to back flex. Rigidity and tread also have an impact as does tire/track slippage. Tires conform to the road differently than the track, so comparability may not be as valuable.
  - Kim agrees, so we need to document this to build a body of science.
  - Bruce mentioned that PSI does not indicate impacts on tracks—it's the pinch points, the initial approach, and the uniformity of loading. Randy has done a good job of figuring out if the Bigfoot tire even works, and now we can look at the "why" with a scientific approach.
- Kim asked if you could share/display results of the visitor use survey, particularly the results of those questions with "yes" or "no" responses.
  - Randy gave out a questionnaire last winter and is happy to modify the survey based on feedback from this group. Let's just keep it short so it isn't taxing to the visitor.
  - Randy gave copies of all of last year's surveys to Wade.
  - Randy described how surveyed passengers had to switched between Bigfoot and Matrax vehicles to let them compare the two types of snowcoach. We need to think about the wording of the comparability question because even after they switched, many passengers did not know what a Matrax was.

- Randy's questions were open-ended, so in the future we should think about closed questions (yes/no, multiple choice, etc.) so we can easily quantify the results.
- Wade can send the surveys to Kim, who would like to see them and volunteered to help draft future questions.
- Kim asked if the Park could elaborate on the other "big tire" applications in use around the world, and can you provide some information based on their experience that can help this group better understand the pros and cons of bigfoot tires?
  - Randy himself has experience with Bigfoot vehicles in the racing world, which is where he got his initial interest in mechanics. He wanted to get up to speed on new technology, so he contacted people all over the world as he developed this project, including: The designer of the first Bigfoot tundra buggy at Churchill, Canada; Arctic Trucks, who design arctic racing trucks (a 39" tire was the first to win the overland race to the pole); Chris Sawyer, the British Military balloon tire authority; Dennis Franklin, an engineer with Interco Tire; he is very interested in this project and has been a great resource and that most people who use snow roads are moving from tracks to balloon tires.
- Bruce asked if Randy or Wade have contacted Parks Canada to see how they control rutting in their parks.
  - Wade described how he and Molly have not found any literature from Parks Canada in their literature reviews, but Bruce is welcome to ask his contacts if he has the time.
- Clyde asked about the snow conditions from Bruce's photo from a Canadian park—are they always on hard tundra or ice?
  - Bruce said they encounter all types of snow conditions, and even bare ground. Randy mentioned that Antarctic and Arctic trucks go up to 8,000' and encounter both snow and hardpack.
- Wade asked if the term "Bigfoot" was incorrect and if we should we term this ongoing experiment something like "big tire" until something more concrete materializes with respect to this as a viable and accepted venture for Yellowstone?
  - Wade doesn't disagree that we need a new name for this project and encouraged this group to come up with a few ideas that we can choose from.
- Someone asked about a second year of the study?
  - Wade said that yes, the NPS wants to build on past data and experience and is soliciting applications for volunteers for the study. Anyone with a concessions contract is eligible and should contact Wade Vagias at [Wade\\_Vagias@nps.gov](mailto:Wade_Vagias@nps.gov).
  - Who is interested/who is invited to participate in year 2?: So far Randy Roberson, Scenic Safari, and Jerry Johnston from West Yellowstone, and Yellowstone National Park have expressed interest in participating.
- What are the requirements for year 2 in terms of design/build specifications for vehicles and reporting?
  - Wade answered, that at minimum, all wheeled snowcoaches operating in the park during the 2014/2015 winter season shall be equipped with:
    - i. Four-wheel drive with a fully locking front differential and, at minimum, a limited slip rear differential. Unlimited slip (aka open) differential-equipped snowcoaches are not

- permitted. Wheeled snowcoaches shall be operated in four-wheel drive mode and with the front differential locked unless executing a tight radius turn;
- ii. Shock absorbers or other bounce-dampening devices of sufficient size and resistance to limit porpoising of the snowcoach to the extent possible;
  - iii. An axle ratio that allows the vehicle to be operated within its normal power band/RPM range. A minimum axle ratio of 5.0:1 or lower is required to achieve this desired state;
  - iv. Bead-lock wheels or similar to allow the tire to be aired down in soft conditions;
  - v. The ability to air up or down the tires in the field as conditions dictate either through an on-board permanently mounted or portable air compressor system.
- By participating in this pilot study each operator agrees to:
    - Allowing the NPS to test the impact of their wheeled snowcoaches on aspects related to snowroad rutting and exterior noise emissions, as well as allowing Yellowstone staff to engage in discussions with clientele who toured the park on a wheeled snowcoach;
    - Logging each roundtrip into the park taken by wheeled snowcoaches and reporting these results to the NPS in spreadsheet format at the conclusion of the 2014/2015 season. At minimum, the park is interested in round trip mileage (as recorded by GPS or similar device), total fuel consumed, destination and route, number of passengers, and attributes of the snowcoach such as tire size, gear ratio, and operating air pressure of the tires. The NPS will provide a standardized reporting tool in advance of the start of the 2014/2015 winter season;
    - Their full participation in the development of a “Year Two Status Report” at the conclusion of the 2014/2015 winter season that outlines lessons learned and suggestions for future years if extension of this project proves worthwhile.
  - Kim asked how this program fits into the OSV rule definition in the SEIS and how it would work in the long-term—what would the NEPA process look like to implement the Bigfoot program?
    - Wade responded that the definition of “snowcoach” in the SEIS dropped the word “tracks” to encourage innovation. If the Bigfoot program is less harmful than tracked vehicles, we would not have to do additional NEPA analysis.
  - Kim asked if we need a snowcoach certification process with annual inspections. He has heard that operators want to see a process like this.
    - Wade said he is working on developing a **Snowcoach BAT Approval, Certification, and Inspection Process**.
  - Clyde clarified that the contracts are good for 10 years and the vehicles approved under them are good for 10 years. Therefore, innovations can be adopted, but they are not required.
  - Jack asked how the NPS and operators will know if Bigfoot is what the visitor wants to see.
    - Wade said there are a variety of ways to ask the public, including operator-provided surveys, NPS staff feedback, the Adaptive Management Program, and NPS-sponsored surveys.
    - Bruce suggested developing criteria for a unique look and feel to avoid confusion.
    - Randy mentioned that about 99% of his survey results indicate satisfaction with the experience of the Bigfoot.
    - Bruce offered to supply the survey results from replacing the White motor coaches in Glacier.
  - Randy clarified that he moved back to Mattrax in the beginning of the 2013/2014 winter season because he only had small tires and wheels and didn’t like their performance in the Old Faithful parking area.

- Randy brought up the point that driver fatigue is a very important issue, which the Bigfoot project may address. This affects safety and visitor experience, so how can we fold this issue into the program's process?

### Supplemental Reading Material

Status Report: Yellowstone Bigfoot Project Year 1: Winter 2013/2014

### Comments Received Before the 6/1/2014 Conference Call:

Kim Rapp, via email on 6/23/14: Thanks for sharing Randy's Bigfoot project report with the work group. While I found this report to be interesting it also seems to have many information gaps which in turn generated several questions. While I don't know that my questions necessarily equate to agenda questions or topics, I figured I'd share them in case any help build a better discussion agenda:

- Figure 6 would be much more useful if it provided miles per gallon (MPG) data. The only trip where a clean calculation seems to be possible is on March 4 where the 'notes' state that it was a 185 mile trip – which would appear to result in a 5.5 mpg. There appears to be about a half dozen 'Old Faithful' trips where one could perhaps presume about a 61 mile round-trip from his shop – and consequently get some mpg calculations in the range of 4.9 to 6.3 mpg. Otherwise most of the journal entries are of little value. While the narrative states that fuel consumption falls between 1/3 and 1/2 half of tracked coaches, nothing in the report substantiates this (so it would have been better to include another Figure outlining his tracked coach's data comparison).
- I'm puzzled as to how the 42" tire photos/comparison relates to the study data since nothing like this was tested? I guess if the point is to show they are too darn big to fit within the wheel wells – point made but that could have been done with one photo.
- If we're going to be making comparisons between tracked versus wheeled vehicles, some calculations regarding PSI should be made and included in the report discussions.
- I would like to see the 'results' of his visitor survey rather than just getting the questions and a few summary/observation comments. While some of the questions were open-ended, others were more yes/no or a subject vote that could be summarized in at least a raw percentage.
- The report makes reference to other 'big tire' applications around the world but does not include any specific examples of successful ventures elsewhere – and rather only makes a jump to his recommendations. It seems like if we're going to go down this road there is an information gap which may help further the group's understanding of pros and cons based upon other applications with more experience.
- It seems a bit premature to me to be worrying about the best marketing name (Discovery, Explorer, etc.) for this vehicle type. If anything I find 'bigfoot' to be a misnomer and would say simply calling it the 'big tire' vehicle venture is sufficient until something more concrete materializes in respect to this be a viable and accepted long-term venture for YNP.

### Comments Received in Response to the Call

From Bruce Austin, via email on 7/16/2014

Randy and Wade,

I wanted to make clear my gratitude for the work you've done, Randy, and report that you prepared on the

flotation tire technology investigation of over snow travel in Yellowstone.

I think that you have done a great job and proven much about the potential that the technology has to offer. Data gathering will, of course, lead to other refinements and areas to explore to improve the OSV technology.

I think, though, that you have accomplished the "proof of concept" with your work.

My comments concerning the use of shock absorbers to suppress unwanted motion (mostly rocking forward and rearward) were in no way criticisms of the efforts that you have made.

As the tire pressure is lowered and the footprint of the tire (accompanied by sidewall deflection of the tire) increases, the tendency to undergo porpoising greatly increases. At 18 PSI, which I think you pretty much settled on as the best overall pressure, it will be a relatively small problem and pretty well handled with large, stiff shock absorbers. As pressures are reduced, presumably to increase flotation and improve the tendency to reduce rutting, rocking due to tire deflection increases at a disproportionate rate.

For that reason, to insist that more and more shock absorbers be utilized to improve ride comfort under low and very low pressure flotation conditions is essentially pointless - it is likely that with the shocks that you have used, you have suppressed essentially all the unwanted motion that can be passively eliminated, since the shock absorbers do not suppress unwanted movement due to tire deflection.

My concern in hearing Wade's listing of criterion (perhaps hearing mandates where he actually intended suggestions) for the year 2 development and monitoring work is that other innovation be prohibited or discouraged.

In this instance, the dynamic shock absorbing technology that BMW (as well as a couple other very high end luxury auto manufacturers) pioneered, now available as a component of dynamic stability control systems is the only technology out there to meaningfully improve the ride comfort when very low tire pressures are used and the suspension is only passively involved in the unwanted motion.

My '88 700iL uses a quick response hydraulic reservoir system (valving the rear hydraulic shock absorbers - which are plumbed into a high pressure hydraulic system that can jack up the rear of the car at speeds exceeding 100 mph (they claim 160, but I regard that statistic as theoretical) to compensate for the deflection of the front suspension and dampen rocking motion by forcing the rear wheels downward when, for instance, a pothole is struck by the front wheels to keep the cabin level and essentially compensate for the irregularity in the road surface.

It takes a little getting used to to experience the sensation of the body slightly lifting when you hit the hole (or, for another instance, a log in the road) while the car seems to sail along unperturbed. It is a bit of the duck serenely cruising along the surface while paddling like hell unseen underwater.

Whether this stimulates Wade's "running over things" video fixation, I don't know, but I suspect that you understand the concept.

The 750iL has the reputation of being a hanger queen almost as legendary as the B-58 Hustler. The Hustler had over 150 fused circuits at the second chair and tube-type technology designed in the '50's for a supersonic bomber with a speed-modulated mechanical control system. With at least 13 computers on board and control systems, valves, and sensors that even the dealership has no record of, the 750iL is simpler, but with much less

of a support system in place to keep it operational - unless the owner is creative.

With just short of a quarter million miles on the clock now, I think that the engineering concepts (which the '88 - especially my No 4 of the first dozen to be built seemed to have to some excess - in addition to the 475 hp naturally-aspirated V-12 that BMW had only previously built for Rolls) have proven sound.

Just who might adapt the dynamic shock absorbing technology to the Ford chassis is something that I could pursue, should you not already know where to check this out, but I know that it has, at least on the Navigator chassis, been prototyped, if not now released on the high end package. Your Ford-authorized (and trained) custom fabricator should be helpful on this.

Just a closing thought (I promise): The idea that anecdotal information is non-scientific somehow and to be avoided is an unfortunate concept that ultimately stalls the scientific process. In most technological evolution, it is the anecdotal information that feeds the process of hypothesis formation, data gathering and proving or disproving the hypothesis - the very essence of the scientific method.

Usually, it is the anecdotal observations of the testing of the first hypothesis that leads to the formation of successive hypotheses that ultimately lead to the "perfect" solution - which is, of course, a never-ending process that keeps the innovative process going.

### **Actions:**

- Wade will distribute the draft notes for Bigfoot (call #6) to the group by 7/14/2014.  
**ACTION: Done**
- Working group member comments are due on the abovementioned call notes to Christina Mills ([Christina\\_Mills@nps.gov](mailto:Christina_Mills@nps.gov)) by Friday 7/18/2014.  
**ACTION: Done**
- Wade will send Kim a subset of completed surveys.  
**ACTION: Working on it...**
- It's been stated (repeatedly) that we need a new name for the Bigfoot Project.  
**ACTION: We're entertaining any and all naming options.**

### **Operating Principles:**

- The Adaptive Management Program will be consistent with the framework contained within the final Plan/SEIS, the Record of Decision (ROD), and the final Rule;
- This working group is a portal to encourage creative ideas and insights on how to best encourage and develop new and innovative ideas for winter use in Yellowstone as related to operations and technology;
- We will be respectful of all ideas and each other and will entertain new possibilities and consider how they might work;
- We'll ask tough questions;
- The National Park Service is the final decision-making body for the Winter Use Adaptive Management Program.