Keweenaw Research Center

Research and Development for Snowmobile Trail Grooming Equipment Improvements

Michigan Department of Natural Resources

Attn: Matthew Torreano

By
Russ Alger and Tim Smigowski
Institute of Snow Research
Keweenaw Research Center
rgalger@mtu.edu
(906) 281-1569

Michigan Technological University
Keweenaw Research Center

Table of Contents

List of Figures

BACKGROUND

The Keweenaw Research Center (KRC) of Michigan Technological University (MTU) was contracted by the Michigan Department of Natural Resources to analyze prime mover failure and maintenance costs coupled with assessments of potential retrofits to reduce both cost and down time. This contract started on 9/12/2019.

KRC is a research branch of Michigan Technological University. KRC's mission is to support education at the University through the involvement of students and faculty on funded projects undertaken by KRC. KRC is largely a vehicle research entity. The majority of the projects performed at KRC involve vehicle components, systems, and platforms as well as terrains including soils, pavements and snow.

Groomer purchase data and maintenance / repair data were received from the DNR over the course of the project and used for analysis.

SCOPE OF WORK

A general scope of work is broken out in the RFP as follows:

a. Gather and analyze data on common groomer failures
b. Gather and analyze data on common groomer failure repair costs
c. Development and establish bid specifications to incorporate in future groomer purchases to enhance durability on snowmobile trail groomers
d. Develop design specifications that most efficiently fix and compensate for the common groomer failures
e. Make recommendations for future groomer purchasing

To accomplish the desired SOW, KRC worked with MIDNR and the various clubs to obtain failure and repair documentation at the onset of the project.

KRC analyzed the failure data on the following grooming manufacturers used in Michigan and ranked the top failures based on likelihood to reoccur, number of occurrences, and cost to repair.

- Tucker
- Pisten Bully
- New Holland
- John Deere
- Bombardier/Prinoth
- Sousy
- Zuidberg

KRC worked with several members of MIDNR, the Snowmobile Advisory Workgroup (SAW), the Equipment Subcommittee of SAW, and various clubs to obtain as much failure and repair documentation as was available. From this data, a list of the most common failures and repairs of grooming equipment that is used by the various clubs and grant sponsors in Michigan was developed. Coupled with this list were the costs for these repairs. Also, the most common and most expensive failures are further analyzed to develop ways to reduce failures and costs. Finally, recommendations for specifics that could be written into design and bid specs are made.

To accomplish the outcome of this effort, the repair data received from MIDNR was input into an excel work file. This file and the data inputs were manipulated to simplify search and querying the data to develop failure trends by part and by manufacturer.

INITIAL ANALYSIS

Data Collection and Organization

Most of the data used for this analysis was obtained from the MIDNR. The majority of this information came in the form Amendments and Equipment Status Reports (ESRs). There was also data collected in a survey conducted by MTU. All of the data provided was from the years 2015-2022. The amendment data was provided in multiple excel files that were sorted by year and contained information such as machine repair costs and descriptions of what was repaired. The ESR data provided is information gathered from each club at the end of each season that is uploaded into a .pdf file. This data was sorted by year and club and contains information on each club's grooming mileage and machines. The ESR mileage data includes assigned miles, groomed miles, and groomed hours. The ESR equipment data includes data about the individual units that each club owns or owned such as make, model, year, engine make, horsepower, odometer reading, hour reading, and a description of the equipment condition.

After obtaining all of the data, it was then organized into a format that made it easy to search through and analyze. Categories were made that include club name, year, repair description, machine make, machine model, machine year, tires or tracks, tire/track brand, repair category, and cost of repair. After the data was sorted into a usable format, plots were created and trends started to be found. Once trends in the data were found, it was broken into different tabs within an excel file and a table of contents was created in order to make it easy to navigate through and further analyze.

Club Survey

An on-line survey was developed and sent to the listed contacts at each of the various snowmobile clubs and grant sponsors. This survey contained a short set of questions that were intended to get answers for some background information from the clubs. The following list are the questions asked in the survey:

1. Club Name?
2. Your Name?
3. How many miles of trail do you groom?
4. How many miles do you have to deadhead to you trail system?
5. Do you groom mostly in the day or night?
6. How many different operators do you have?
7. Are operators paid or volunteer?
8. Do you do your own maintenance?
9. What are your 3 most irritating maintenance issues?

An excel file containing all of the responses to the survey accompanies this report. Figure 1 is a graph showing the breakdown of operators in the clubs that answered the survey. As expected, the majority are volunteers.

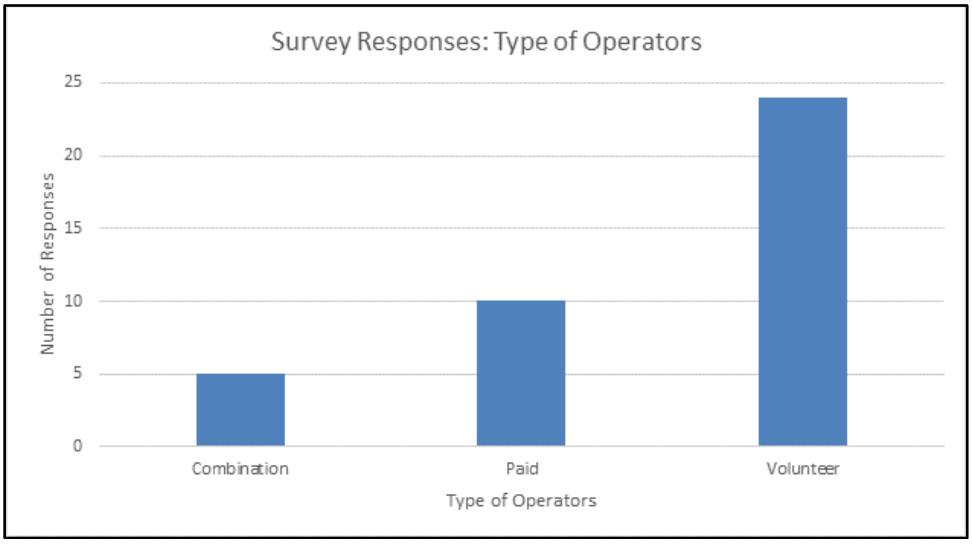

Figure 1. Club Operator Type

Figure 2 contains the breakdown of time of day of grooming. Most clubs appear to groom day and night.

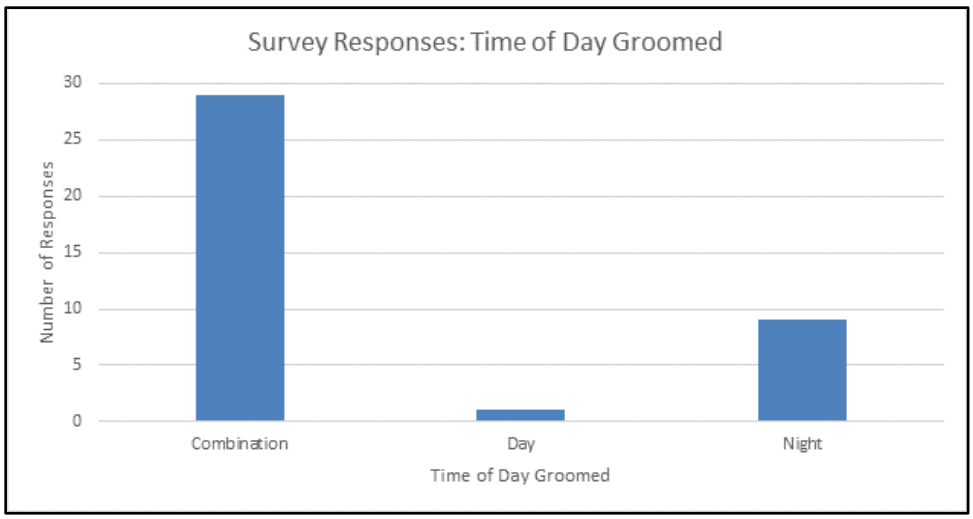

Figure 2. Time of Day Groomed

Figure 3 contains the answers from the questions that asked what are the most important issues related to grooming for each club.

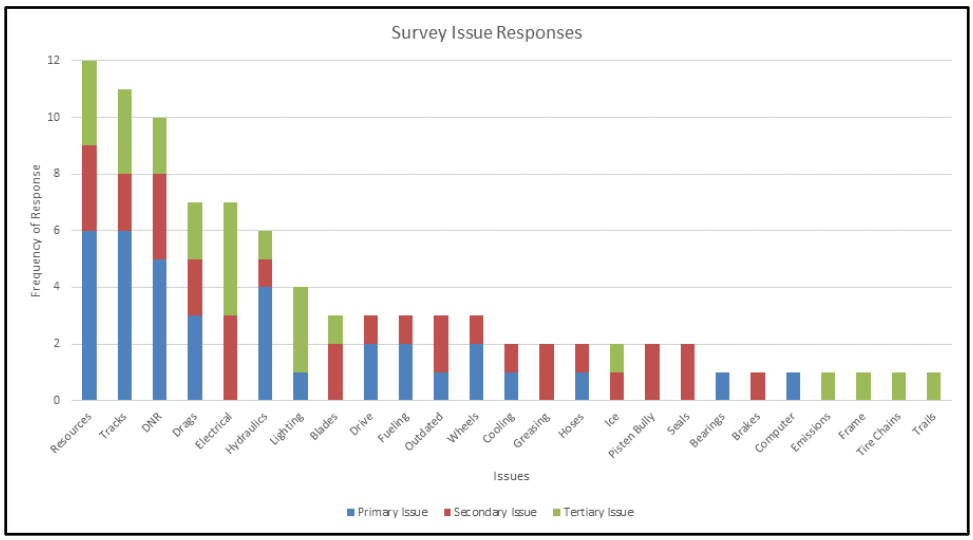

Figure 3. Survey Issue Responses

Figure 4 is the data for mileage from where the groomer is parked to the trail system (deadhead miles). For most clubs this mileage is low.

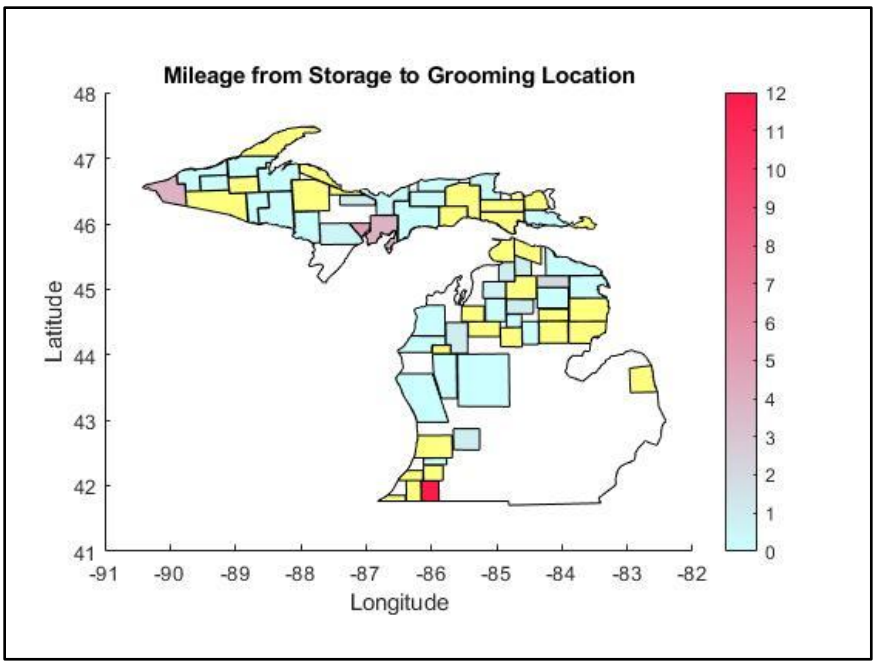

Figure 4. Deadhead Mileage

GROOMING EQUIPMENT SPECIFICATIONS AND ANALYSIS

As mentioned previously, all of the maintenance and repair data received from MIDNR was accumulated in an excel file. The file has been sent to MIDNR and is separate to this report. This data was massaged in an attempt to make it easier to search. Repair and maintenance reports were individually studied and the information from each was input into this file. The file also contains a number of tabs that analyze the original data in different ways.

A large set of Powerpoint slides was also put together to accompany this report. This presentation contains graphs and data intended to be used to relay information to clubs, grooming equipment sales representatives, and groomer manufacturers where appropriate.

Figure 5 is an overview of the current equipment inventory for the program as of spring 2022. There were 232 total Prime Movers in the program when the final data was accumulated for this project analysis. The five major prime mover companies used by the program are broken down in the figures.

- Total Prime Movers: 232
  - Total Tractors: 138 → 60% of machines
    - John Deere: 80
    - New Holland: 45
    - Other – Case 6, Kubota 2, Fendt 2, JCB 2, CAT 1
  - Total Tracked Prime Movers: 94 → 40% of machines
    - Pisten Bully: 43
    - Tucker: 43
    - Prinoth: 7
    - Other – ASV 1
- Total Clubs: 69
  - Clubs with Tractors: 53 → 77% of clubs
  - Clubs with Tracked Prime Movers: 41 → 60% of clubs

Figure 5. Prime Movers in the Program

There are also numerous drag manufacturers used across the program. This equipment was not studied to the degree of the prime movers because the cost of purchase for most are similar and the repair costs are low compared to the prime mover costs. Figure 6 is an overview of the drags being used in the program during 2022 broken down by manufacturer. Figure 7 is a snapshot of the repair costs on drags during the study period.

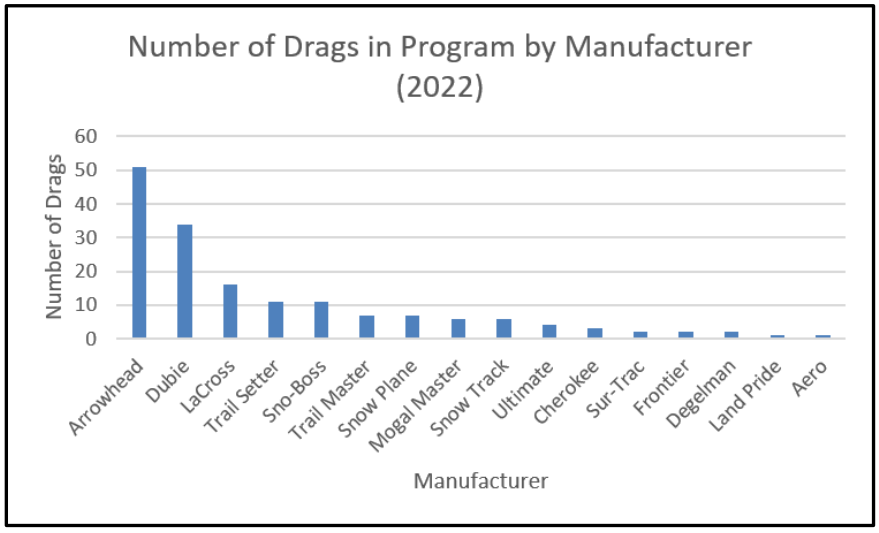

Figure 6. Number of Groomers by Manufacturer

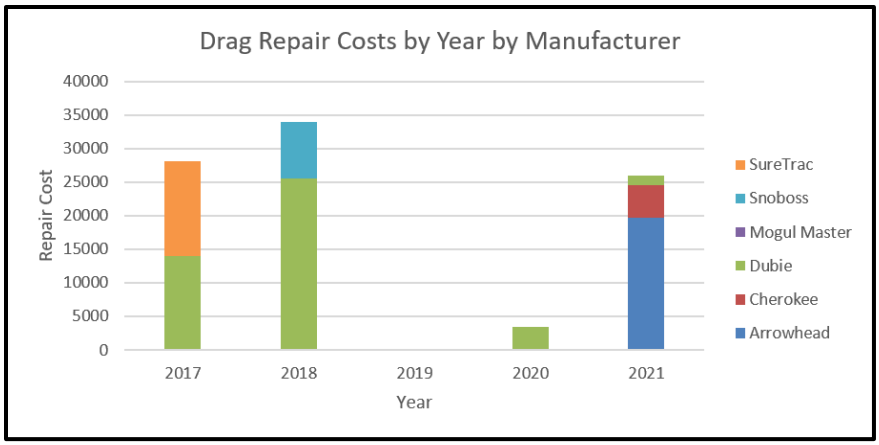

Figure 7. Repair Costs for Drags

There are 2 major wheeled tractor types used: John Deere and New Holland. Most of these units have tracks added, but they were mostly designed to be wheeled. The other tree prime mover types, PistenBully, Tucker, and Prinoth, are permanently tracked.

The figures contain breakdowns of the different models as well as a broad overview of repairs. These categories will be further analyzed later in this report.

The following figures contain specific data for each of the five major Prime Mover types. There are a number of models of John Deere Tractors used. The major breakdown of models is shown in the figure. John Deere has models that incorporate their own track design, and others use add-on track pods. Figure 8 shows the numerous models of John Deere tractors used.

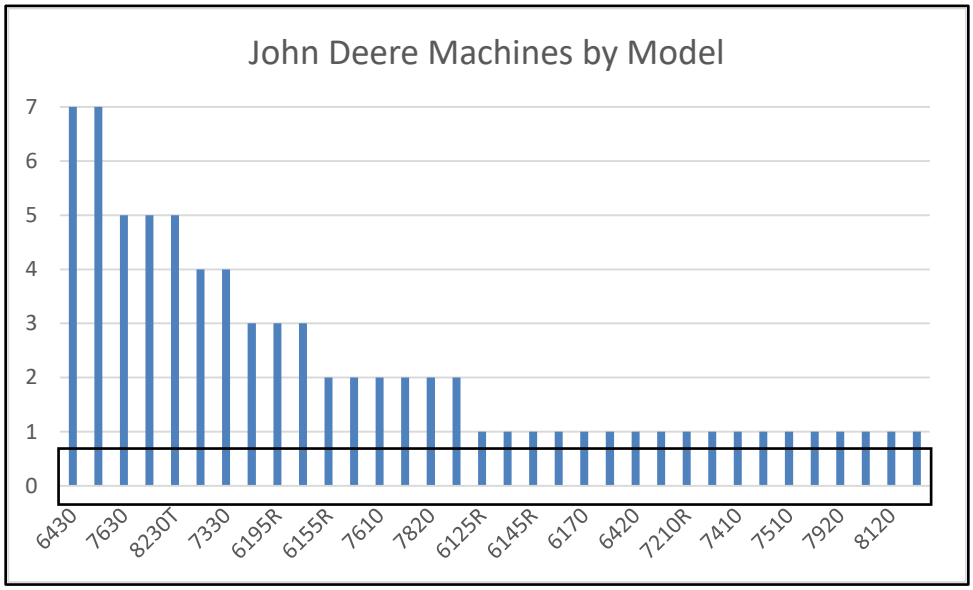

Figure 8. John Deere Models

Figure 9 contains a breakdown of the New Holland tractors. Most of these units are tracked. The newer purchases are set up with 4 tracks, with most 2 track, Sur-Trac systems being phased out. The trend appears to be a move to the higher HP units.

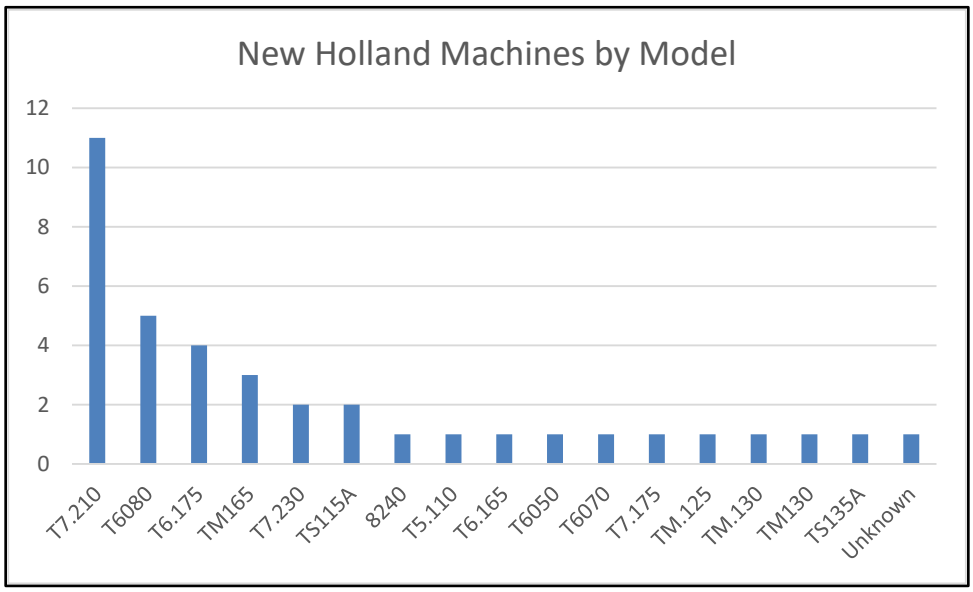

Figure 9. New Holland Models

Figure 10 contains data for the PistenBully tracked prime movers. There are 4 models used for trail grooming.

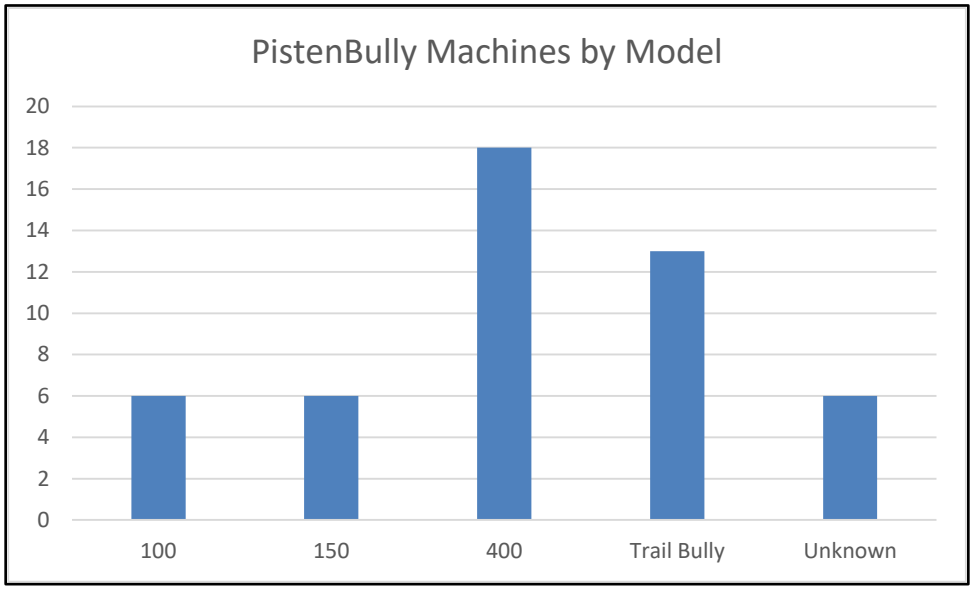

Figure 10. PistenBully Models

Figure 11 is the Tucker overview. There are 5 models used in the program.

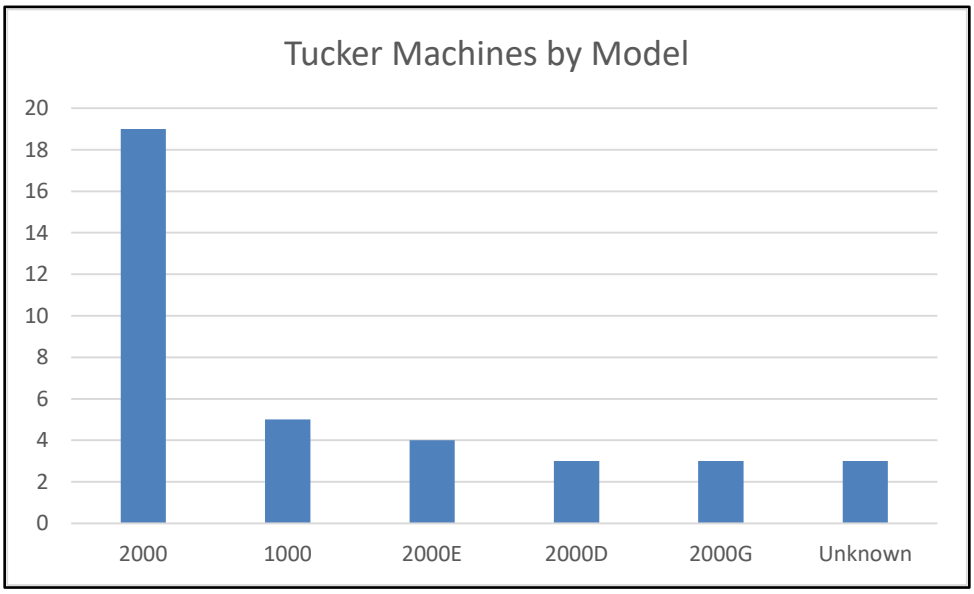

Figure 11. Tucker Models

Figure 12 is the Prinoth data. There are 3 models in the program.

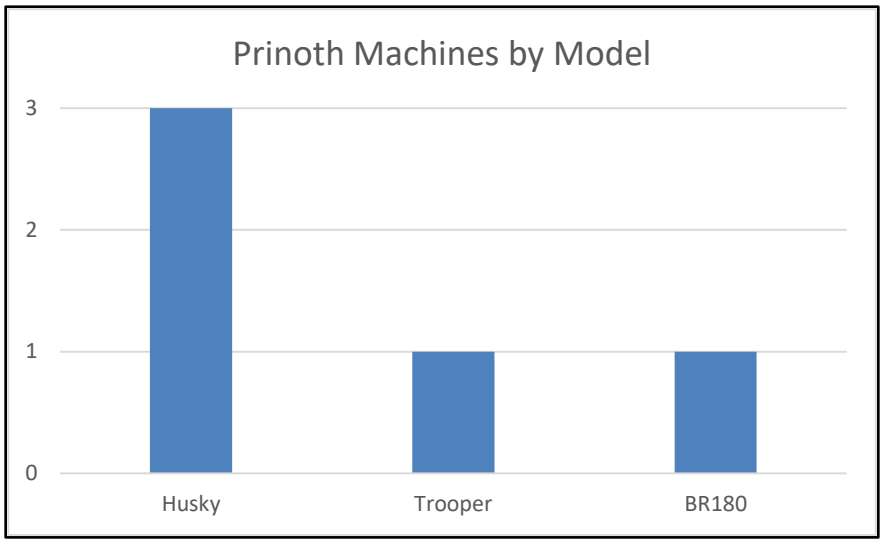

Figure 12. Prinoth Models

Club Information

The End of Season Reports (ESRs) were used to gather data on each club. This club data is represented by geographic heatmaps created in MATLAB and Google Earth. Each club's geographic location was determined from the Michigan DNR's ArcGIS snowmobile map. This map was used to create boundary areas for each club in Google Earth, which was then exported to MATLAB. In MATLAB, specific data was added to each shape, which is then represented by different colors to create a geographic heatmap. The heatmaps were used to identify trends and determine whether any clubs significantly deviated from those trends.

Club data was used to determine the "cost per mile" for each club, which is the club's total repair costs divided by their assigned miles. This shows how much money each club is spending on repairs in proportion to the number of miles they are required to groom. A higher cost per mile can indicate relatively high repair costs, few assigned miles, or a combination of both. Figure 13 and Figure 14 show the overall cost per mile for each club based on data from 2017-2021.

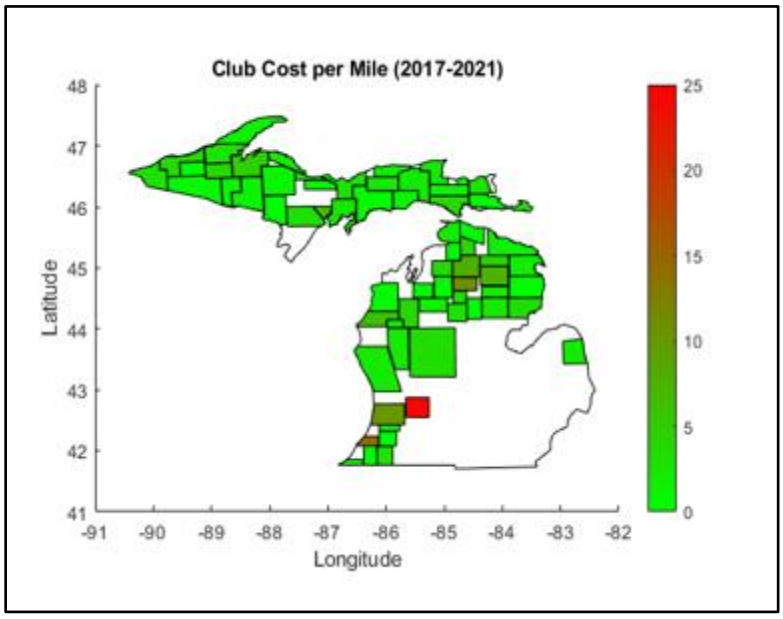

Figure 13. Club Cost per Mile

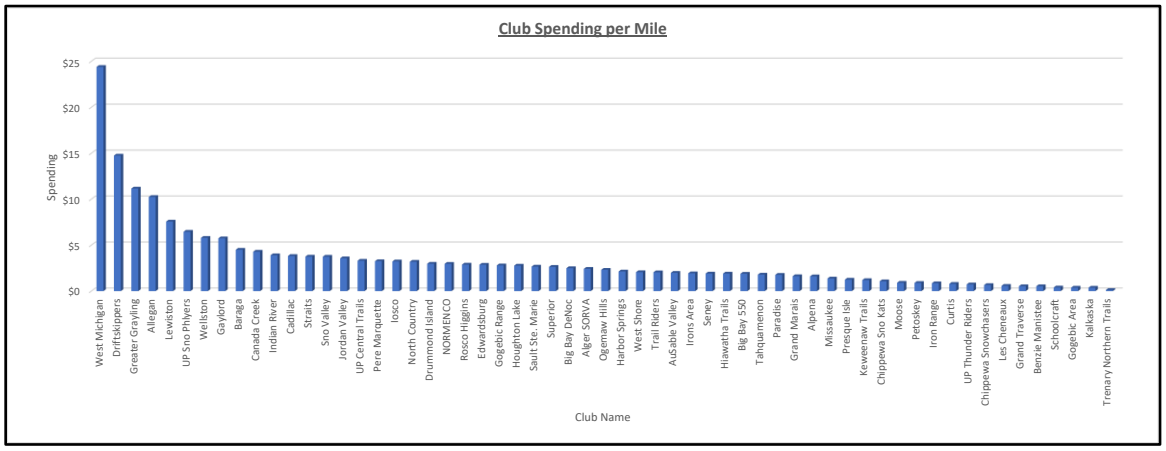

Figure 14. Club Spending per Mile

Snowfall data was collected from the National Weather Service using snowfall accumulation graphs for each club's geographic location. Each season's data begins on October 1st and ends on May 30th. Figure 15 through Figure 17 show several season's snowfall for each club.

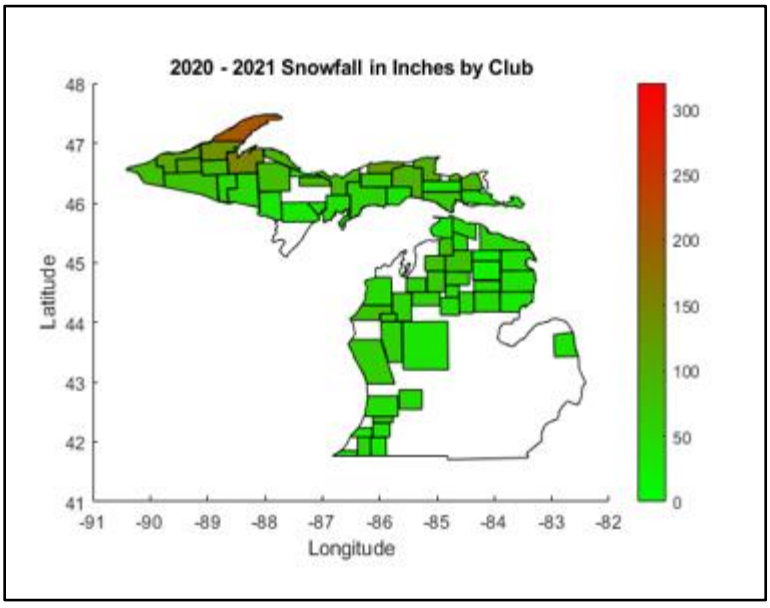

Figure 15. 2019-20 Snowfall

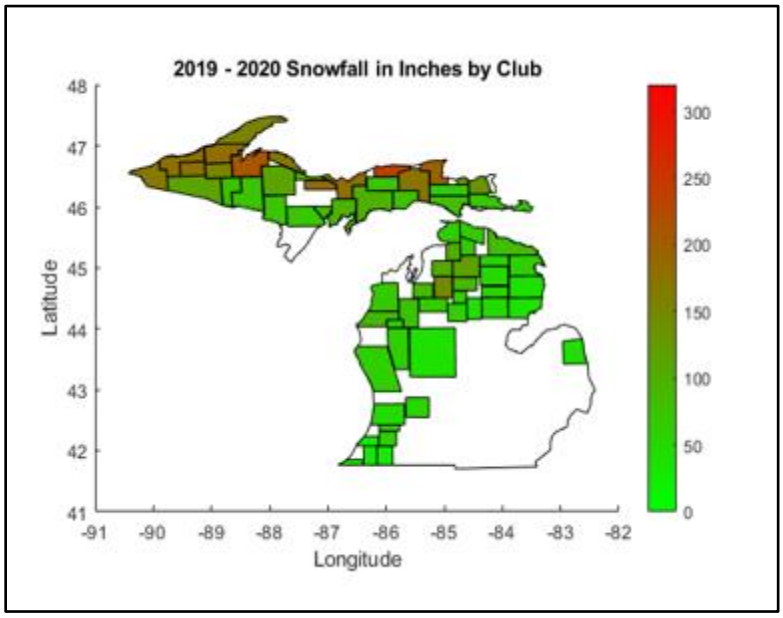

Figure 16. 2020-21 Snowfall

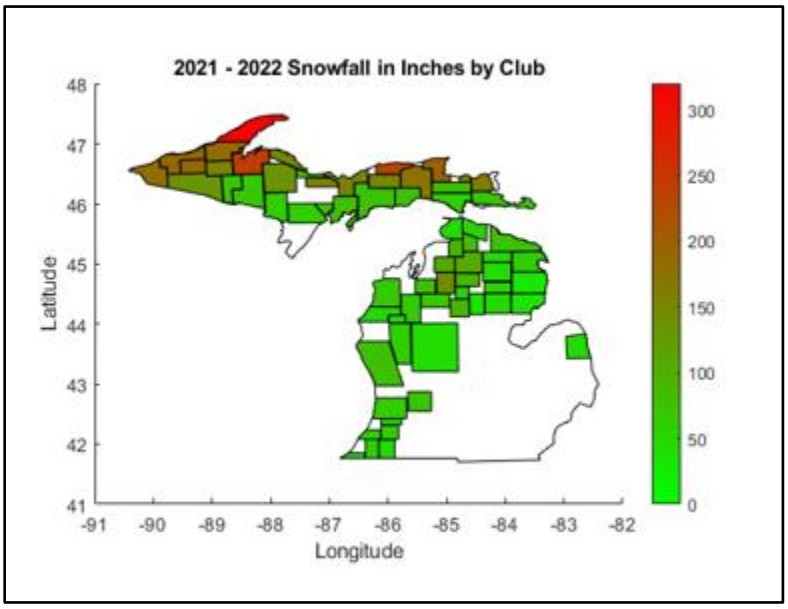

Figure 17. 2021-22 Snowfall

ESR data was used to generate heatmaps that depict the miles groomed by each club per season and the number of Prime Movers used per club. Figure 18 through Figure 21 below show this data. If data for a club was not available, that is represented in the heatmap by the color yellow.

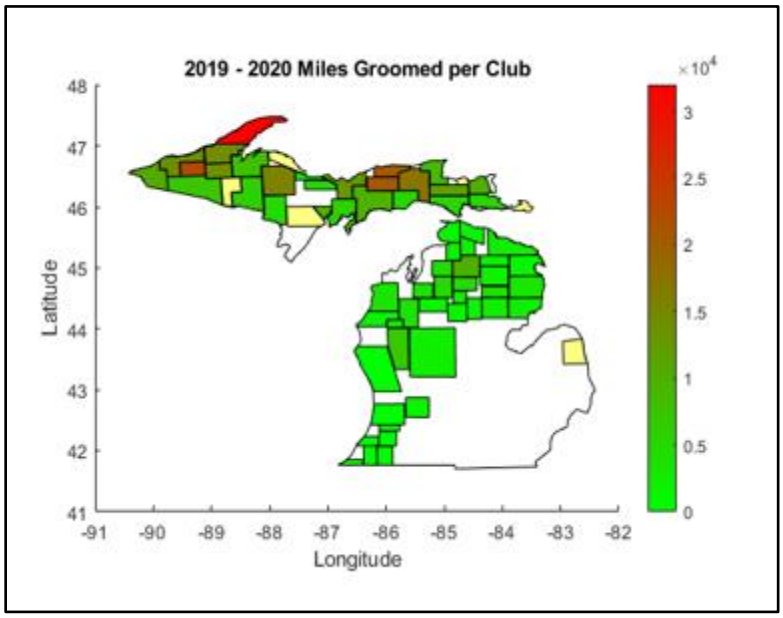

Figure 18. 2019-20 Miles Groomed per Club

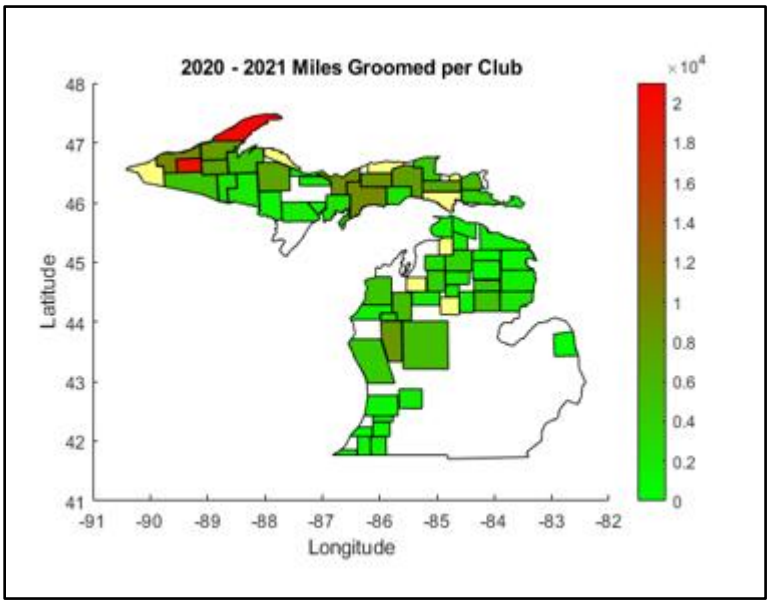

Figure 19. 2020-21 Miles Groomed per Club

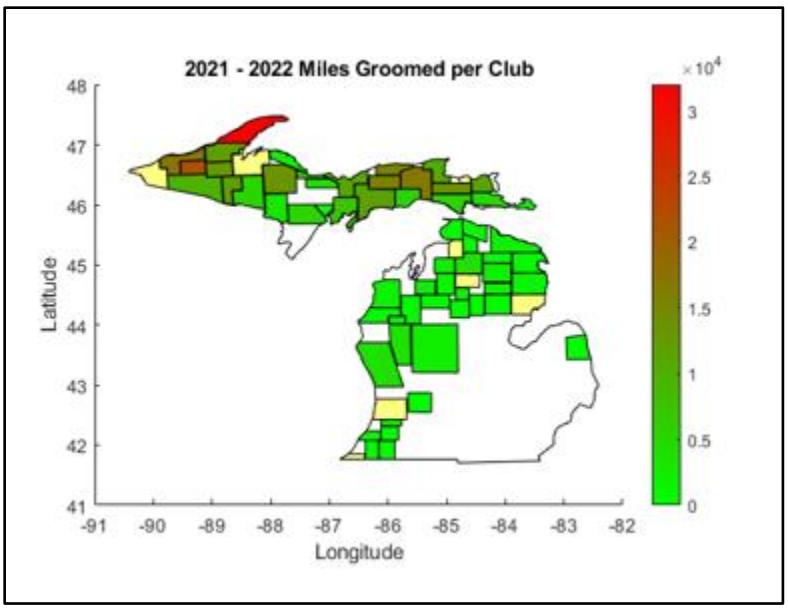

Figure 20. 2021-22 Miles Groomed per Club

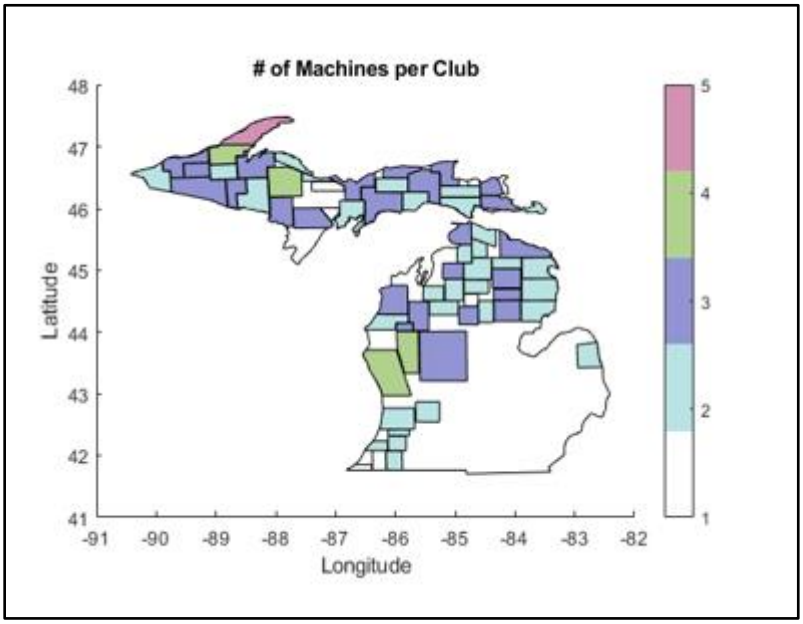

Figure 21. Number of Prime Mover per Club

The repair logs provided by the DNR were used to determine the total repairs, repairs by season, and repairs per mile for each club. Repairs per mile shows the number of repairs by a club divided by the number of miles they groom. This can show trends within the program relating to miles and repairs and any outliers. This data is represented by Figure 22 through Figure 27 below.

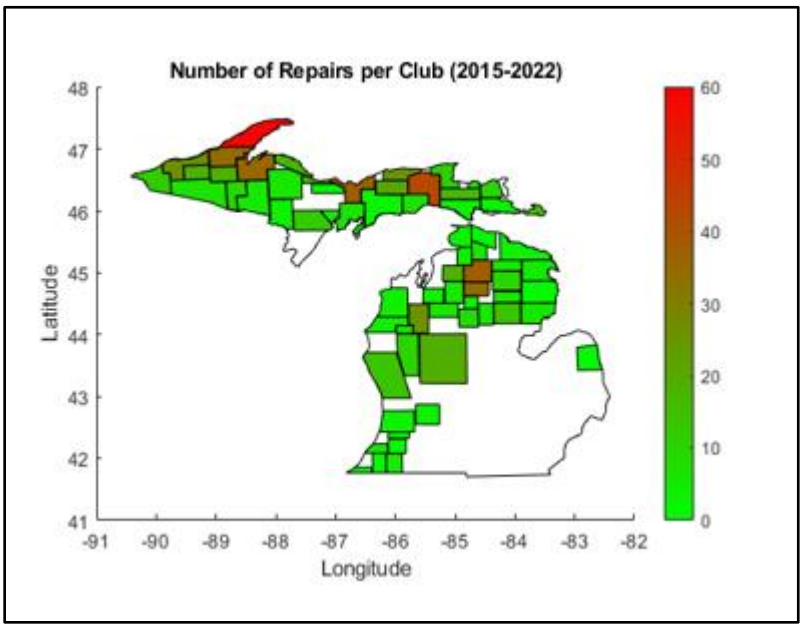

Figure 22. 2015-22 Repairs per Club

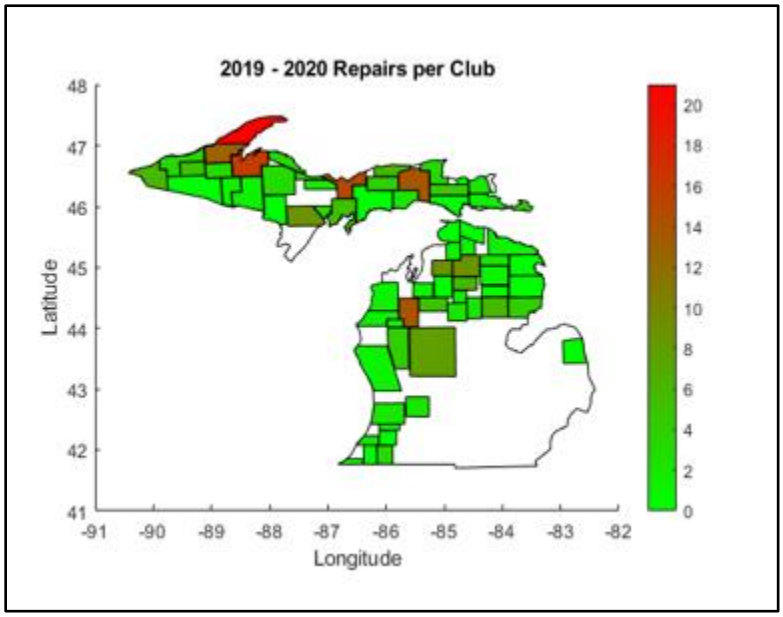

Figure 23. 2019-20 Repairs per Club

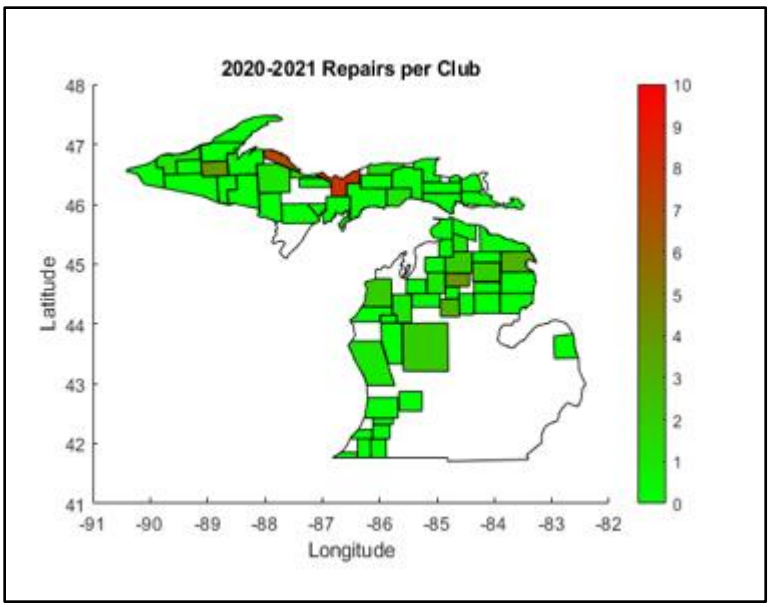

Figure 24. 2020-21 Repairs per Club

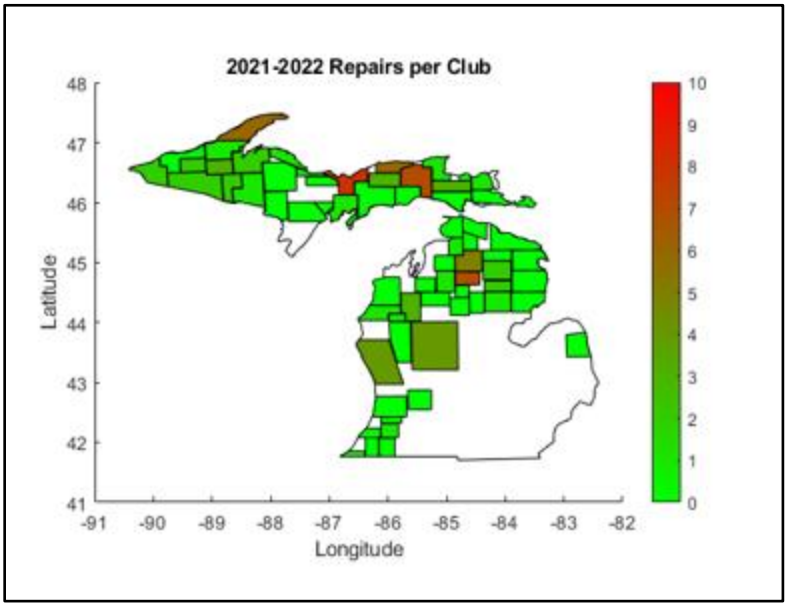

Figure 25. 2021-22 Repairs per Club

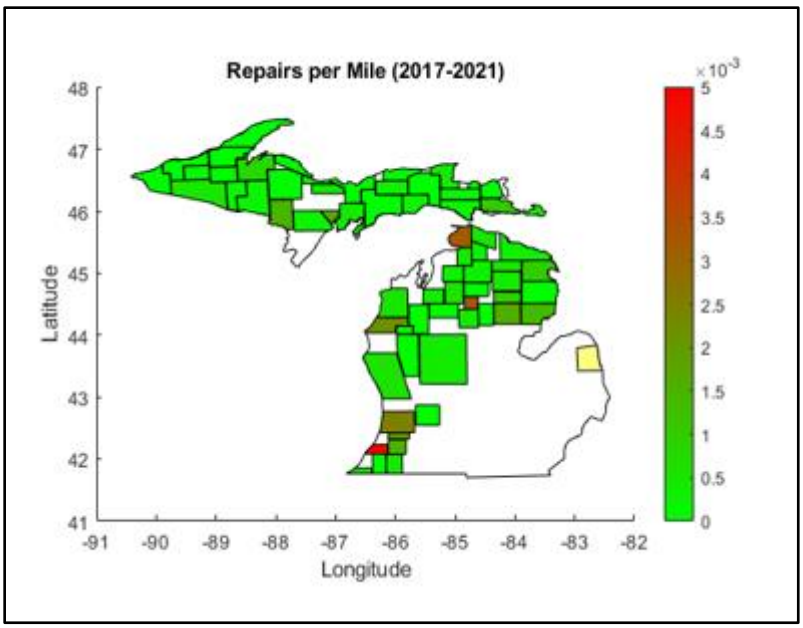

Figure 26. 2017-21 Repairs per Mile

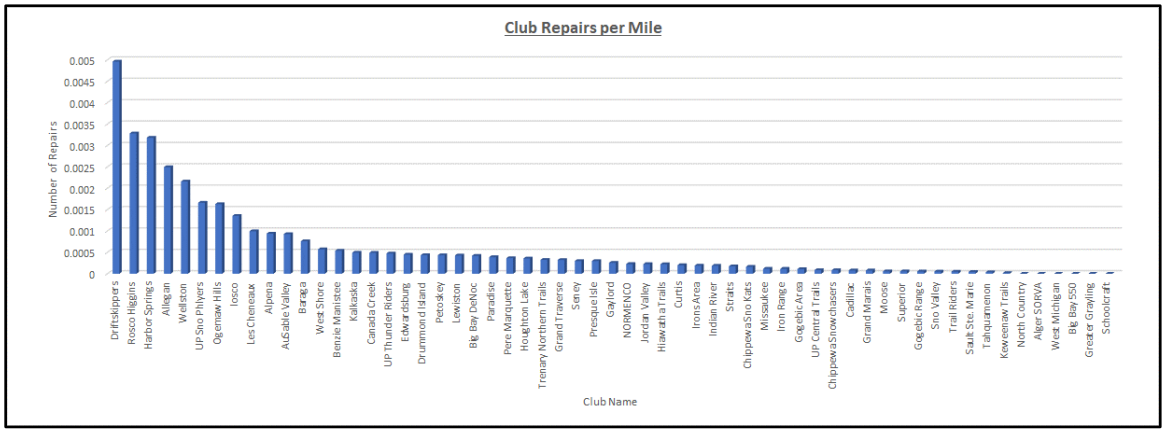

Figure 27. Club Repairs per Mile

The DNR Purchase data was used to determine the number of new machines each club received between 2018 and 2021 to replace an older machine. This data is shown in Figure 28 below.

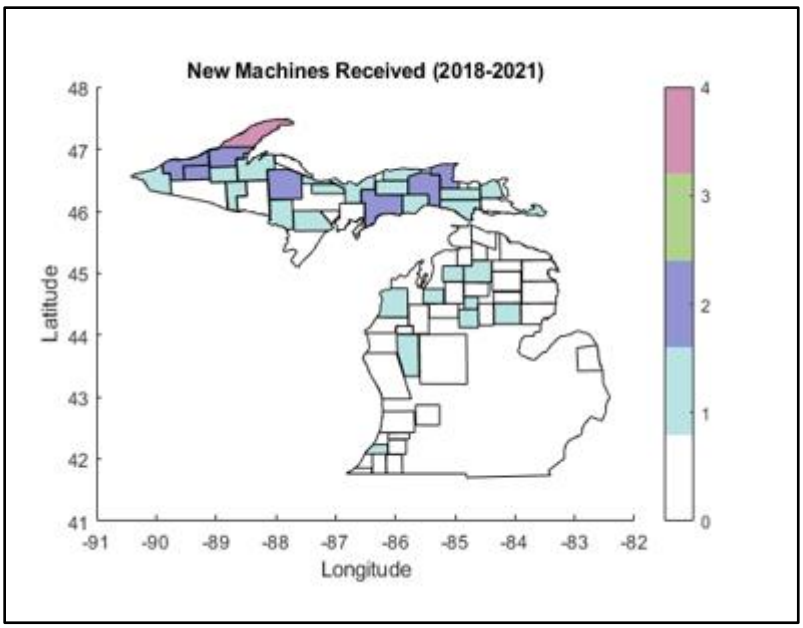

Figure 28. New Prime Movers Purchased

Replacement Data

The DNR's 2015-2021 Purchase Data was used to determine at what age and hour count Prime Movers tend to be replaced. The Purchase Data includes a list of Prime Movers that are to be purchased each year as well as the Prime Movers they are replacing. Data for new and replaced Prime Movers included manufacturer, model, year, and cost. The ESRs were used to supplement the data for the Prime Movers being replaced, specifically to determine the number of hours each Prime Mover had accumulated.

Between 2018 and 2021, thirty-four Prime Movers were replaced. Their ages ranged from six years to twenty-four years. Figure 29 shows the ages of the thirty-four Prime Movers that were replaced and the frequency of each age.

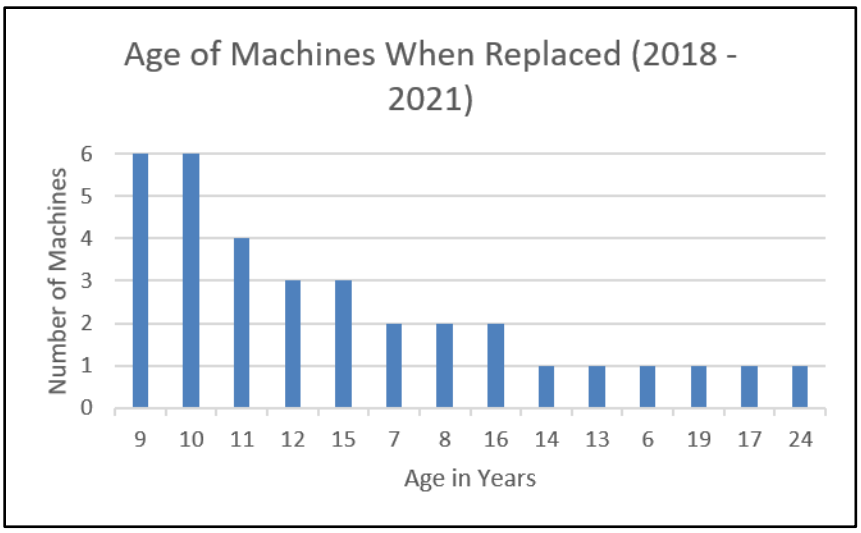

Figure 29. Age of Prime Movers When Replaced

The data from Figure 29 was reformatted into a normal distribution, which shows the probability of each data point occurring in the data set, shown in Figure 30. From this chart, it was determined that it is most likely for a Prime Mover to be replaced after twelve years.

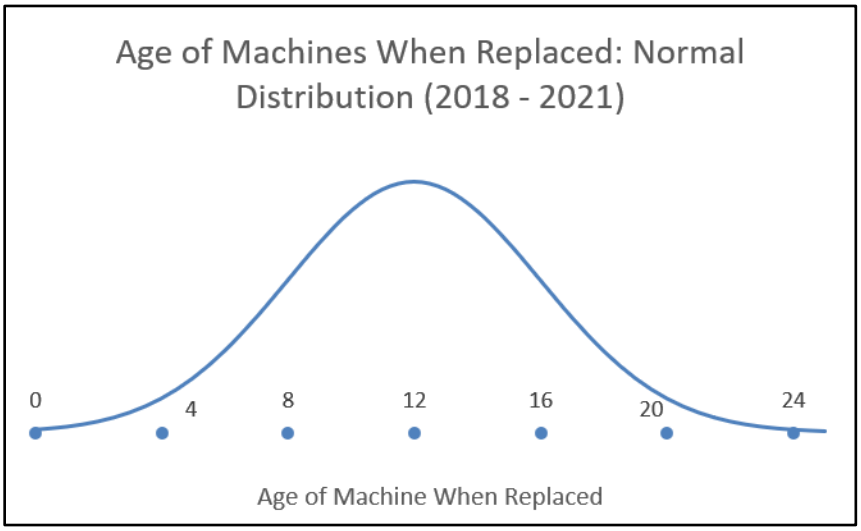

Figure 30. Age of Replacement - Normal Distribution

ESR data was used to determine the approximate hours each Prime Mover had accumulated by the time of replacement. Figure 31 shows the thirty-four data points from each Prime Mover, ranging from 2,489 hours to 10,809 hours.

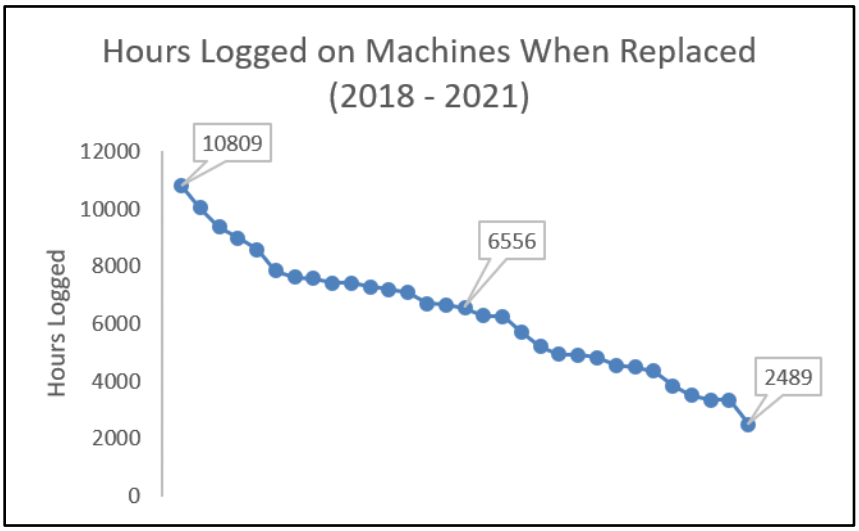

Figure 31. Hours Logged When Replaced

The data from Figure 31 was also formatted into a normal distribution chart. It is most likely for a Prime Mover to be replaced after accumulating 6,289 hours, as shown in Figure 32 below.

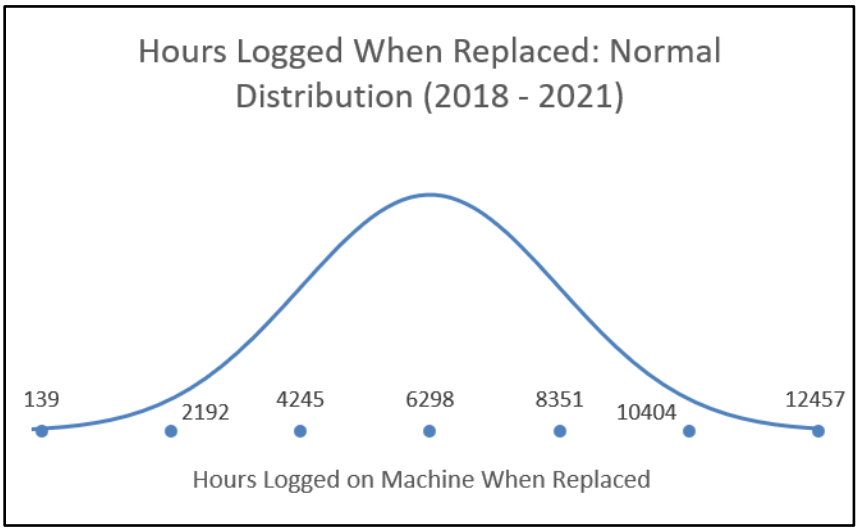

Figure 32. Hours Logged When Replaced - Normal Distribution

The replacement data was then broken down by manufacturer in the same two categories: age and hours. Figure 33 and Figure 34 below show the age of the thirty-four replaced Prime Movers, the frequency of each age, and the manufacturer of each Prime Mover.

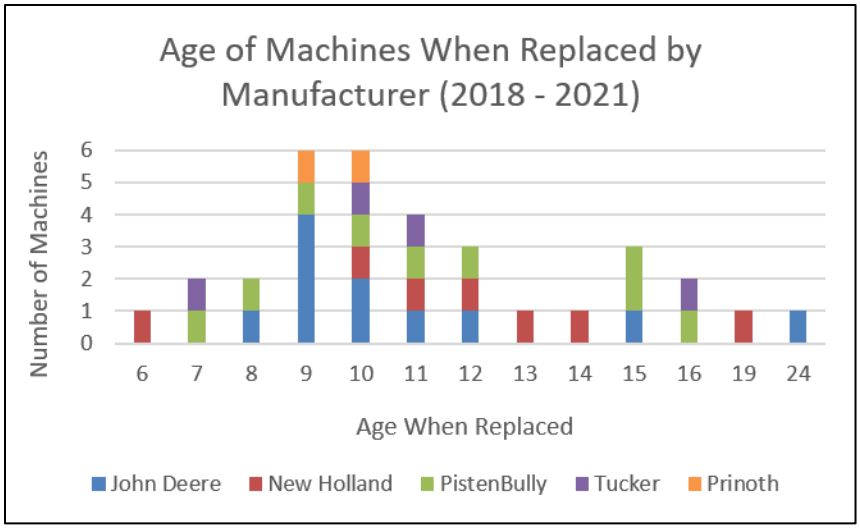

Figure 33. Age When Replaced by Manufacturer

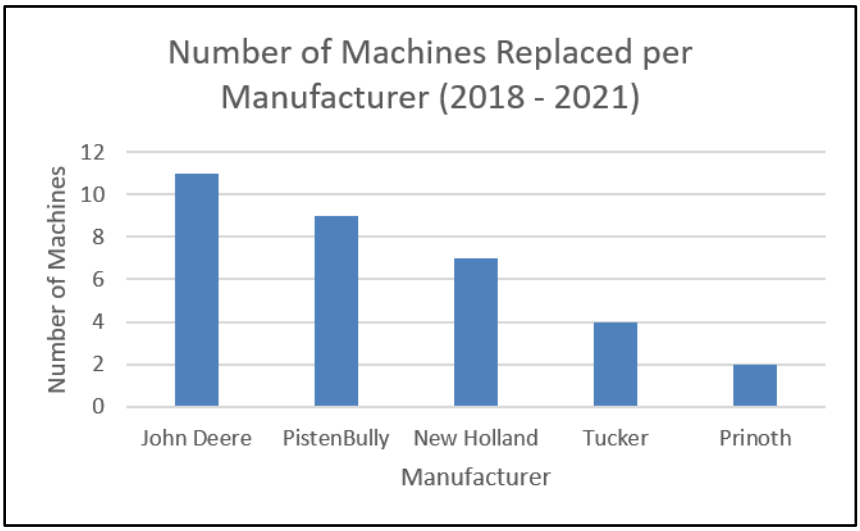

Figure 34. Number of Prime Movers Replaced by Manufacturer

Figure 35 below shows the hour data also broken down by manufacturer.

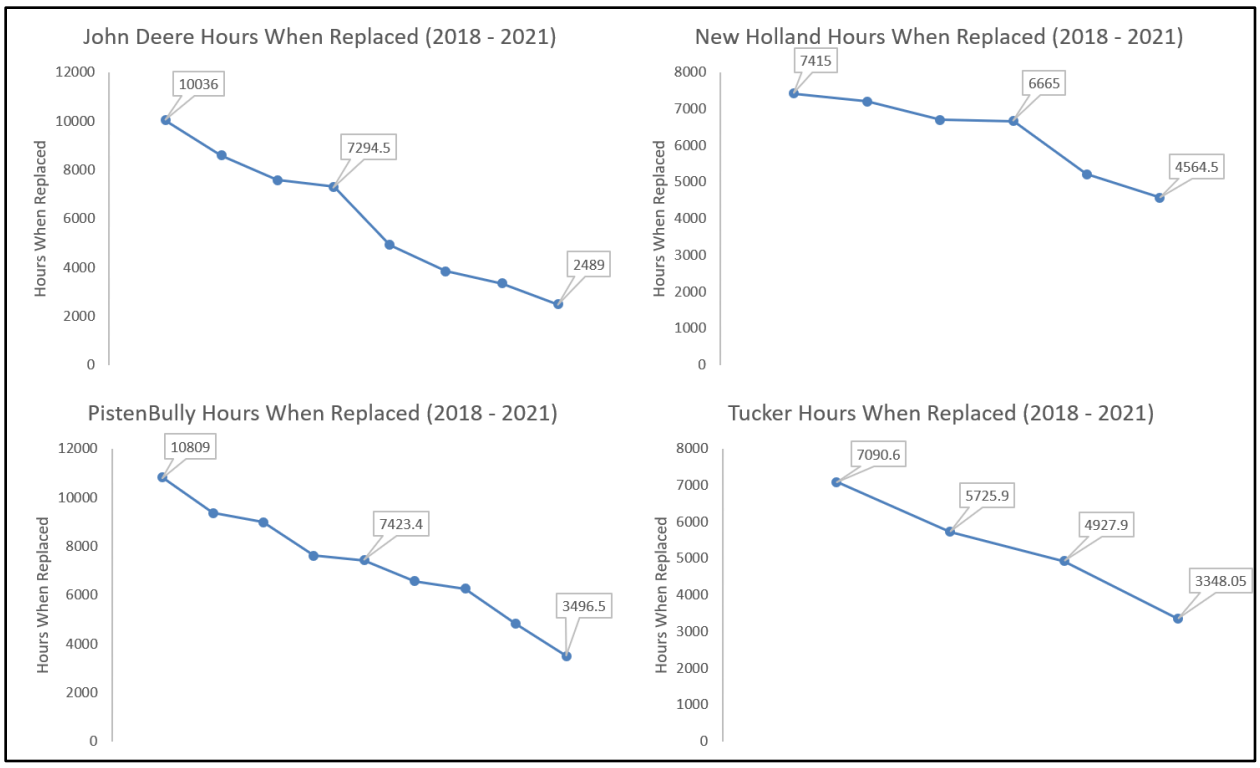

Figure 35. Hours When Replaced by Manufacturer

Lifetime Costs

The DNR's repair logs were used to determine the lifetime repair costs of each Prime Mover manufacturer. This was done to identify trends and determine if any manufacturers do not follow those observed trends. Repair and replacement costs from the repair logs were averaged for each year in the program and added to the previous year's total. This gives an average cost per year after manufacture as well as an idea of the lifetime cost.

As determined earlier, it can be expected that a Prime Mover lasts twelve years. To accommodate any variation, the charts used to show lifetime costs also include lifetime costs for eight and sixteen years, which are one standard deviation below and above the mean of twelve, respectively.

After twelve years, it is expected that a PistenBully will cost the DNR around $61,000 in repairs and replacements. A John Deere will cost around $73,000. New Hollands will cost nearly $100,000, and a Tucker will cost around $89,000.

These lifetime repair costs were then used to determine average total lifetime costs for the main models of each manufacturer in the program. Total lifetime costs include the price the Prime Mover was purchased for and the average lifetime repair costs. Figure 36 through Figure 39 are graphical depictions of this analysis.

These lifetime costs are based on previous purchases, which do not reflect the price of a new Prime

Mover if purchased today. Another chart was created based on the price of new Prime Movers for all four manufacturers. New Hollands equipped with tracks are still the most expensive, with an estimated lifetime cost of $454,000. The least expensive of the four are Tuckers, which have an estimated lifetime cost of $358,000. Figure 40 shows these results.

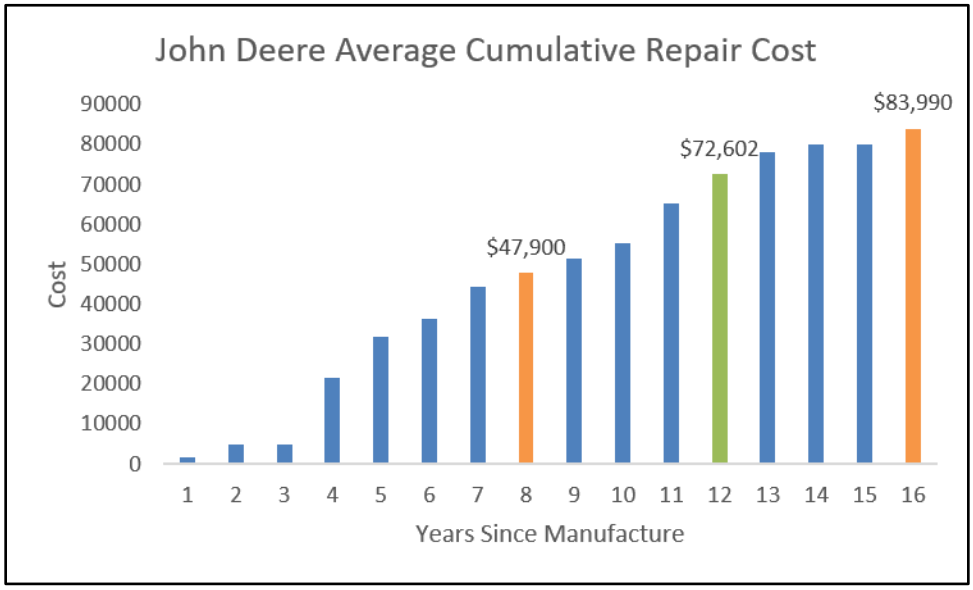

Figure 36. Average Cumulative Repair Cost - John Deere

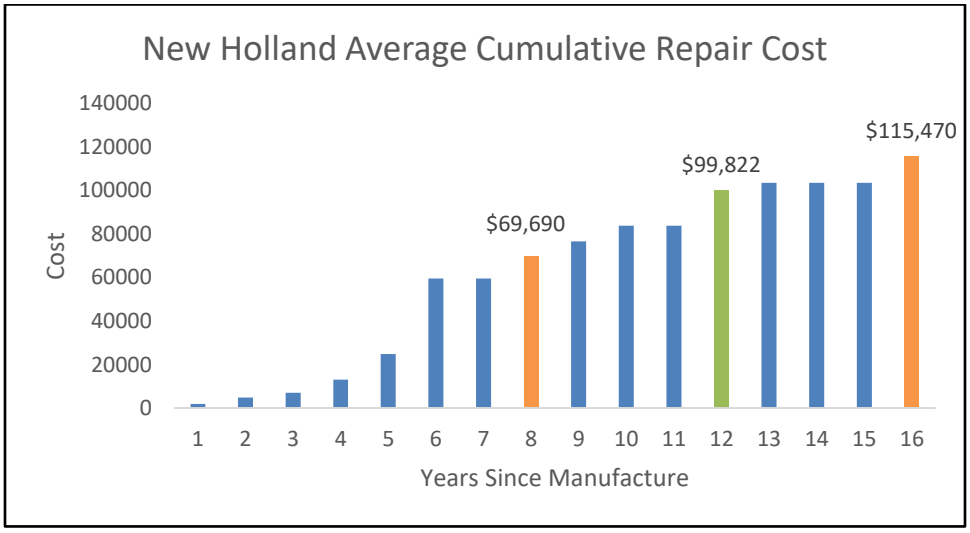

Figure 37. Average Cumulative Repair Cost - New Holland

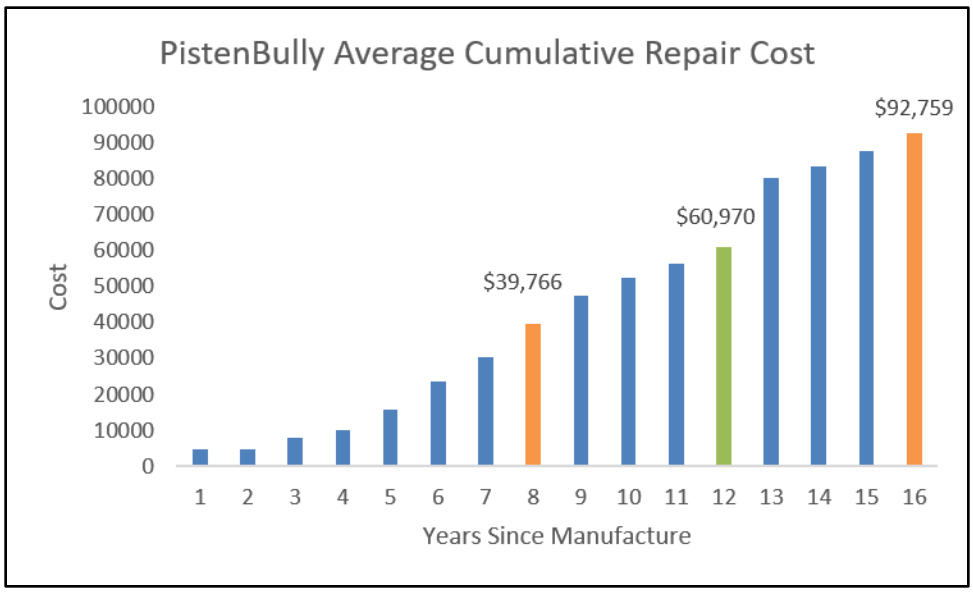

Figure 38. Average Cumulative Repair Cost - PistenBully

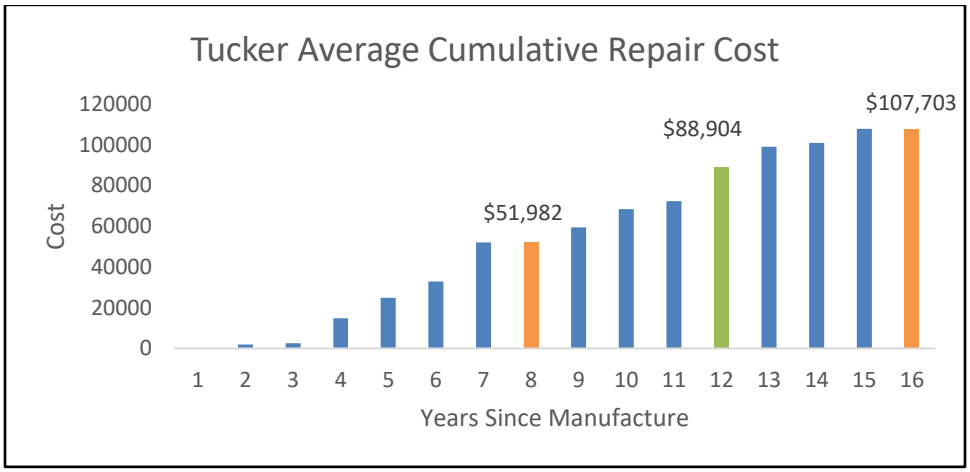

Figure 39. Average Cumulative Repair Cost - Tucker

Average Lifetime Cost per Manufacturer (if purchased today)

	New Machine	Tracks	16 Years Repairs	Total
New Holland	225,000	113,000	116,000	454,000
John Deere	200,000	113,000	84,000	397,000
PistenBully	275,000	Included	93,000	368,000
Tucker	250,000	Included	108,000	358,000

Figure 40. Average Lifetime Cost per Manufacturer

PRIME MOVER REPAIR AND MAINTNENACE ANALYSIS

Figure 41 is a plot of repairs broken down by manufacturer and by repair category for the period of this study. The data for Prinoth is inconclusive because there are not enough units to make a fair analysis. Looking at the other 4, the trends are clear. Tracks, drivetrain issues, and engine issues are the majority of the repairs. Figure 42 breaks this data down in terms of cost, which has similar trends.

The following sections examine the different repair categories by manufacturer. There is some information given regarding tracks on tractors, but a further overview of the relationship of tracks to repairs is given in the section titled "Correlation Between Tracks and Other Repairs" located later in this report.

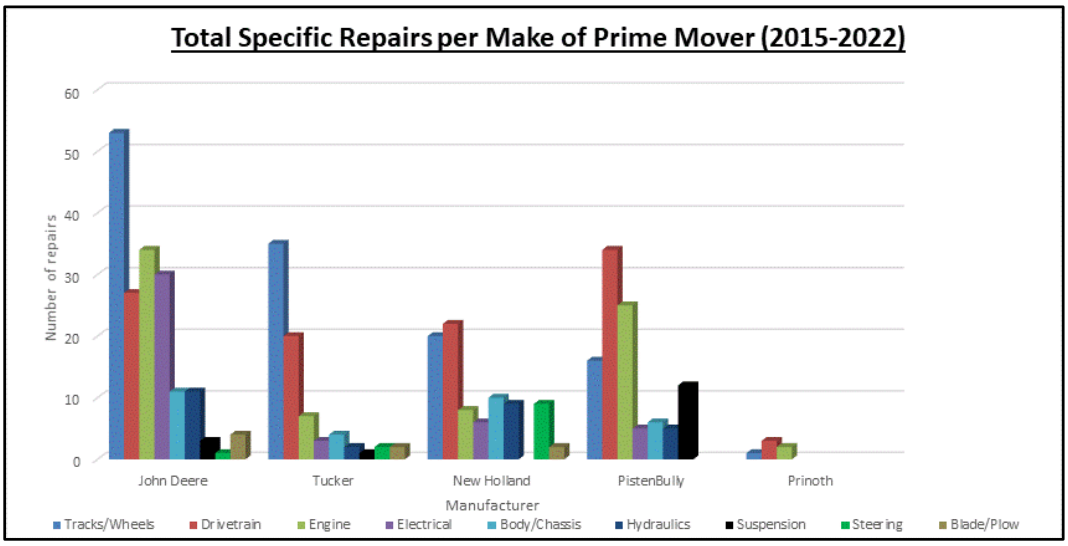

Figure 41. Specific Repairs per Manufacturer

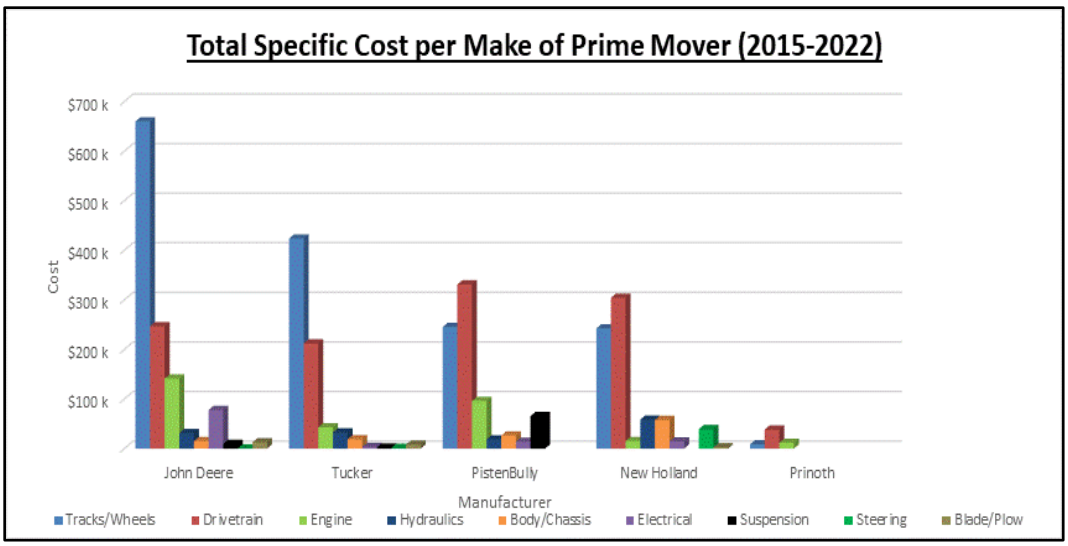

Figure 42. Total Specific Cost per Manufacturer

Figure 43 through Figure 46 break down the common repairs and costs by category and manufacturer of the prime movers: tractors on tires, tractors with tracks installed, and prime movers that are only tracked.

John Deere (Tires)	**John Deere (Tracked)**

• Tires: 17 → 46% of John Deere with tires
  • Tire Replacement: 10
  • Chain Replacement: 1
  • Beet Juice: 1
• Engine: 16 → 43% of John Deere with tires
  • Injector: 4
  • Turbo: 2
• Drivetrain: 12 → 32% of John Deere with tires
  • Transmission: 3
  • Axle: 2
• Electrical:13 → 35% of John Deere with tires
  • Wires: 4
  • Sensors: 4
 	
Average Number of Repairs Per Machine: 2.08
Average Repair Cost Per Machine: $8,240
Average Cost Per Repair: $3,959
	• Tracks: 35 → 74% of John Deere with tracks
	  • Track Replacement: 13
	• Engine: 16 → 38% of John Deere with tracks
	  • Turbo: 6
	• Drivetrain: 15 → 36% of John Deere with tracks
	  • Transmission: 6
	  • Axle: 4
	
	Average Number of Repairs Per Machine: 3.02
	Average Repair Cost Per Machine: $27,592
	Average Cost Per Repair: $9,198

Figure 43. Common Repairs and Costs - John Deere

New Holland (Tires)	New Holland (Tracked)

• Tires: 4 → 25% of New Holland with tires
  • Tire Replacement: 2
  • Chain Replacement: 2
	• Drivetrain: 21 → 78% of New Holland with tracks
	  • Axle: 5
	  • Transmission: 4
	• Tracks: 16 → 59% of New Holland with tracks
	  • Track Replacement: 4

Average Number of Repairs Per Machine: 0.75 Average Repair Cost Per Machine: $3,029 Average Cost Per Repair: $4,038	Average Number of Repairs Per Machine: 3.3 Average Repair Cost Per Machine: $32,675 Average Cost Per Repair: $10,025

Figure 44. Common Repairs and Costs - New Holland

PistenBully

• Drivetrain: 34 → 79% of PistenBully
  • Planetary: 24 → 71% of PistenBully drivetrain repairs
• Engine: 24 → 56% of PistenBully
  • Fan: 12 → 50% of PistenBully engine repairs
  • Alternator: 3 → 12.5% of PistenBully engine repairs
• Tracks: 16 → 37% of PistenBully
  • Track Replacement: 6 → 38% of PistenBully track repairs
  • Cleat/Paddles: 6 → 38% of PistenBully track repairs

Average Number of Repairs Per Machine: 3.07 Average Repair Cost Per Machine: $23,354 Average Cost Per Repair: $7,608

Figure 45. Common Repairs and Costs - PistenBully

Tucker

- Tracks: 34 → 79% of Tucker
  - Track Replacement: 17 → 50% of Tucker track repairs
  - Idler Wheels: 6 → 18% of Tucker track repairs
- Drivetrain: 20 → 47% of Tucker
  - Differential: 6 → 30% of Tucker drivetrain repairs
  - Transfer Case: 5 → 25% of Tucker drivetrain repairs

Average Number of Repairs Per Machine: 2.12

Average Repair Cost Per Machine: $21,358

Average Cost Per Repair: $10,093

Figure 46. Common Repairs and Costs - Tucker

Drivetrain Repairs on Tractors

The following section contains information on drivetrain repairs on prime movers. These repairs are broken down by manufacturer, as well as whether or not the unit is tracked. Figure 47 is an overview of all of the drivetrain repairs on wheeled tractors. In all, there were 30 repairs over the study period. There were 14 on John Deere and 9 on New Holland.

Top Drivetrain Repairs

Tractor Drivetrain Repairs: 30

- Transmission: 15 → 50% of drivetrain repairs
  - John Deere: 8
  - New Holland: 4
  - Case: 2
  - JCB: 1
- Axle: 11 → 37% of drivetrain repairs
  - John Deere: 6
  - New Holland: 5

Figure 47. Drivetrain Repairs Overall

John Deere Drivetrain Repair and Maintenance Analysis

Figure 48 contains the breakdown of wheeled vs tracked units for John Deere. The total contains some units that where unclear of being tracked or wheeled. Figure 49 is the breakdown of axle and transmission repairs as compared to tracked and wheeled units. It can be seen from the available data that there appears to be a trend that both repair types are more common on the tracked vehicles.

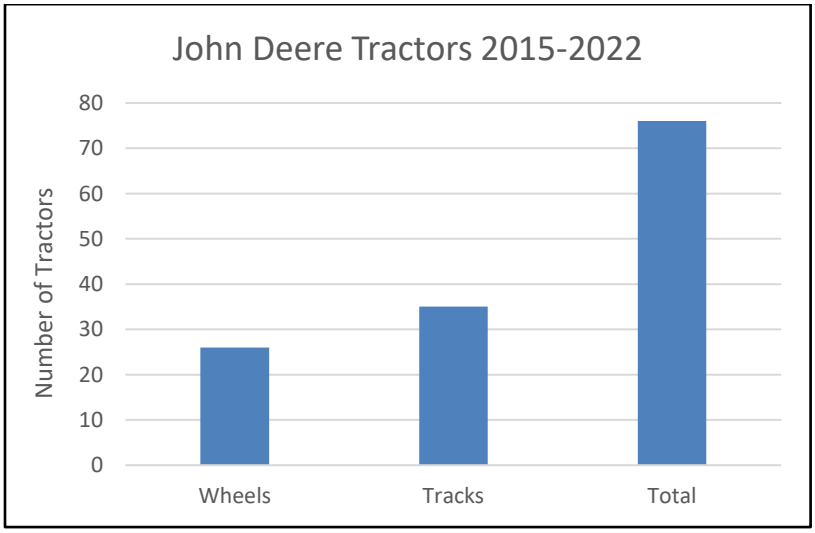

Figure 48. John Deere - Wheeled vs Tracked

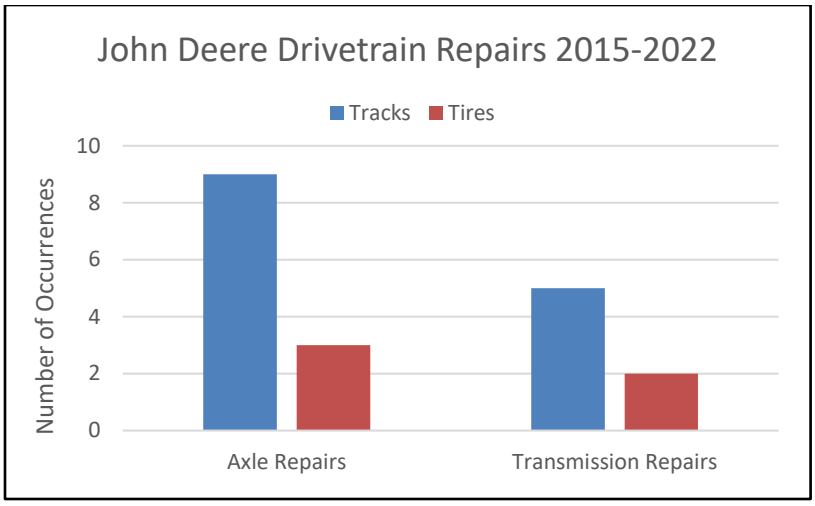

Figure 49. John Deere Drivetrain Repairs

While there were no root cause analyses performed during the repairs on the failures for the John Deere tractors, it is likely that maintenance plays an important role in the failures. Making sure that oil lubrications are changes on schedule is very important. Servicing transmissions on a 300 hour interval is best. A daily check to look for leaky seals, etc., is also important. Making sure that operators report any issues or noises is especially important.

New Holland Drivetrain Repair and Maintenance Analysis

All of the New Holland Tractors in the program are equipped with tracks. Due to the large number of drivetrain repairs performed on tracked machines vs the tire equipped machined, it appears that some of the drivetrain issues can be attributed to the increased load from running tracks. Figure 50 is a breakdown of total drivetrain repairs along with the relationship to axel repairs.

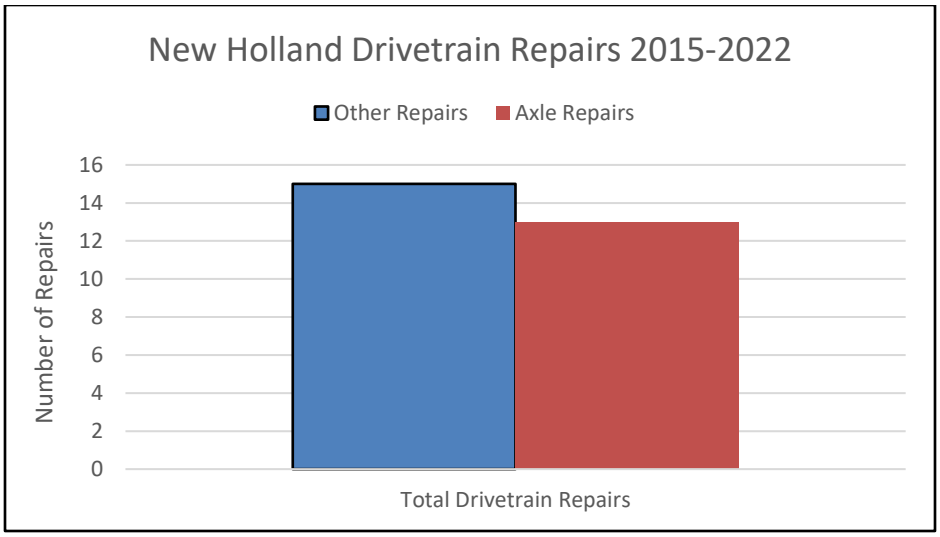

Figure 50. New Holland Drivetrain Repairs

As with the John Deere tractors, maintenance plays an important role in the failures. Making sure that oil lubrications are changes on schedule is very important. Servicing transmissions on a 300 hour interval is best. A daily check to look for leaky seals, etc., is also important. Making sure that operators report any issues or noises is especially important.

Engine Repairs

Figure 51 is an overview of the top engine repairs.

Top Engine Repairs

Tractor Engine Repairs: 27

- Turbo: 7 → 26% of engine repairs
  - John Deere: 7
- Injector: 5 → 19% of engine repairs
  - John Deere: 4
  - New Holland: 1
- Water Pump: 4 → 15% of engine repairs
  - John Deere: 2
  - New Holland: 2

Figure 51. Most Common Tractor Engine Repairs

John Deere Turbo Repair and Maintenance Analysis

There were 9 Turbo repairs on John Deere tractors over the study period. The average cost for these repairs was approximately $3800. Repairs occurred on average at about 3250 hrs.

Recommendations to limit the number of repairs include making sure to check engine oil levels and change the oil at the recommended intervals. Oil starvation is a common reason for turbo problems.

Prolonged periods of idling as well as hot engine shutdown can also lead to increased potential for repairs.

Drivetrain Repairs on Tracked Prime Movers

Figure 52 is an overview of the top prime mover drivetrain repairs. There were 34 total drivetrain repairs on tracked units. The majority of these were planetary drives on PistenBullys.

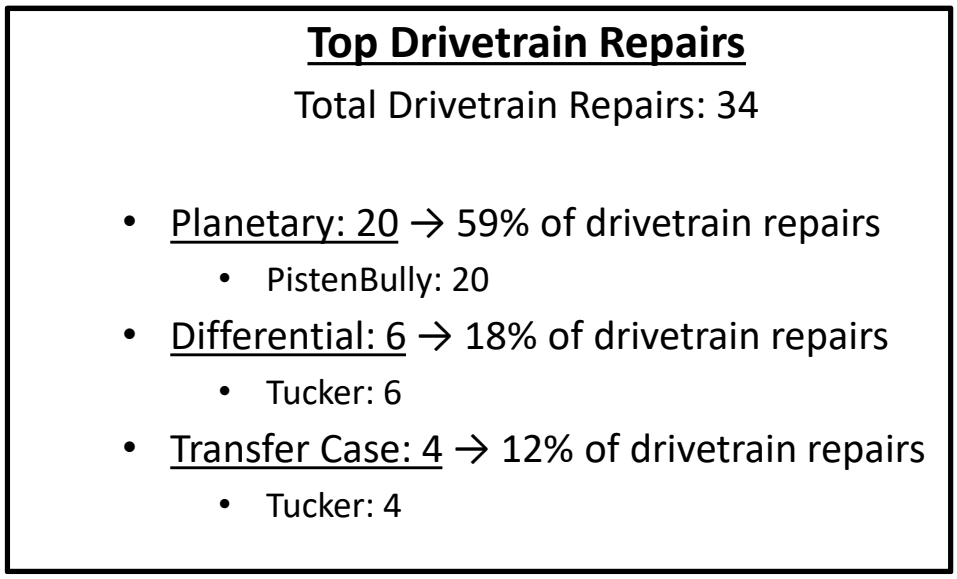

Figure 52. Most Common Tracked Prime Mover Drivetrain Repairs

PistenBully Planetary Drive

There were 26 planetary drive repairs on PistenBully prime movers. The average cost for these repairs was about $8800 and the average time of repair was about 4200 hours.

Again, maintenance is the key for limiting repairs. Talking to PB owners, it appears that changing oil at an interval of 300 hours can help considerably. Also, there is an indication that using Mobil SHC 629 oil can be helpful.

Tucker Differential

There were 13 Tucker differential repairs or replacements. The average cost for these repairs was approximately $2300 and the time repairs were necessary was about 3250 hours.

Recommendations to limit repairs include changing oil at the recommended intervals, inspecting u-joints on a regular basis, and turning off the differential locker when making tight turns, especially when operating off snow.

Tucker Transfer Case

There were 8 Tucker transfer case repairs. The average cost for these repairs was approximately $10,300 and the time repairs were necessary was about 3250 hours.

Engine Repairs on Tracked Prime Movers

Figure 53 is an overview of the top engine repairs for Tracked Prime Movers. The majority of these repairs are Fan / Fan Clutch repairs on PistenBullys.

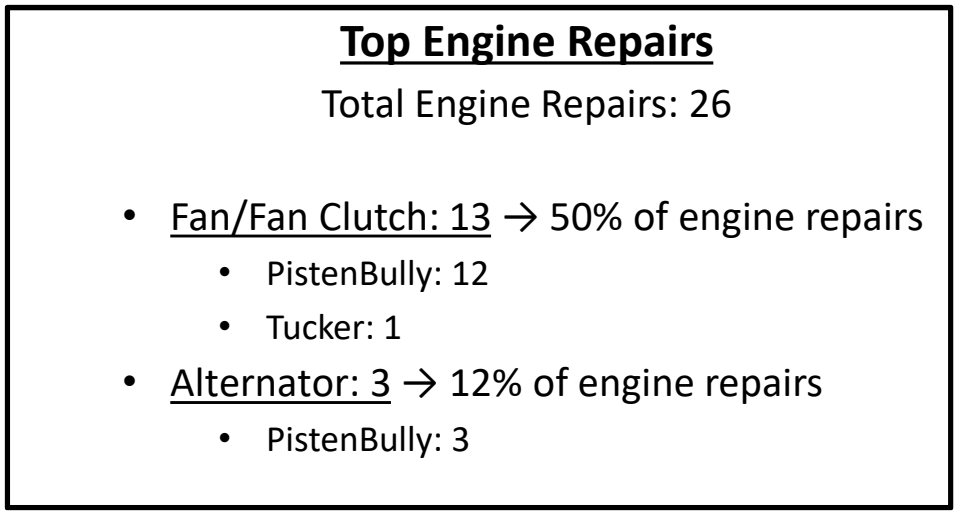

Figure 53. Most Common Tracked Prime Mover Engine Repairs

PistenBully Fan

There were 14 PistenBully fan repairs. The average cost for these repairs was approximately $3400 and the time repairs were necessary was about 3150 hours.

It is recommended to check for obstructions around the fan, and to remove snow and ice from this area on a regular basis.

Tires and Tracks

The snowmobile program in Michigan is complicated by the fact that snowfall varies drastically across the state. There are areas like the Copper Country that consistently get heavy snowfalls that form a snowpack that remains on the ground for several months during the winter. These areas require the use of tracked groomers for most of the winter. Other areas around the state don't get much snowfall and what snows do accumulate tend to come and go throughout the season. These areas are ideal for using groomers that are run on tires only. Some areas in southeastern lower Michigan don't consistently get enough snow to support a trail system at all.

Figure 54 is the same chart that was shown in a previous section. This chart gives an idea of where the heaviest snowfalls are in the state.

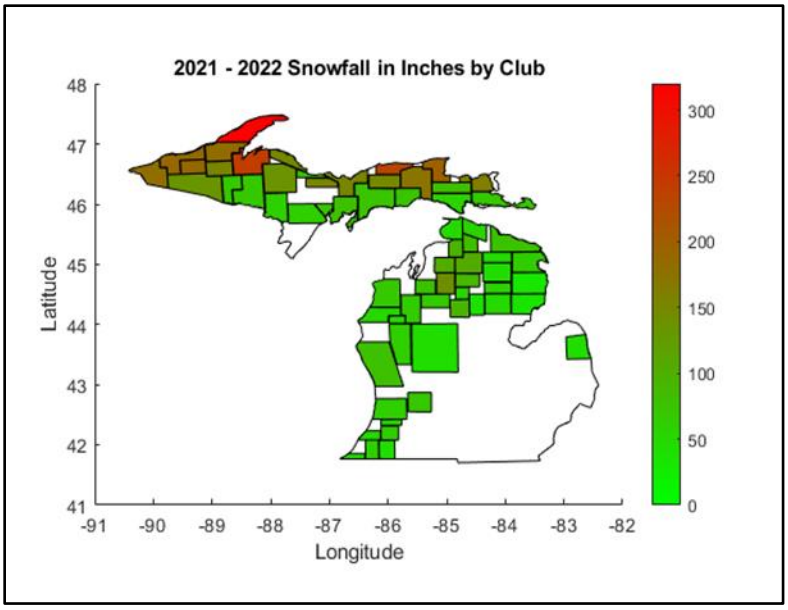

Figure 54. Snowfall 2021-22

Figure 55 is a depiction of where wheeled tractors are used and where tracked prime movers are prevalent. As expected, for the most part, the tracked units are concentrated in the snowiest areas.

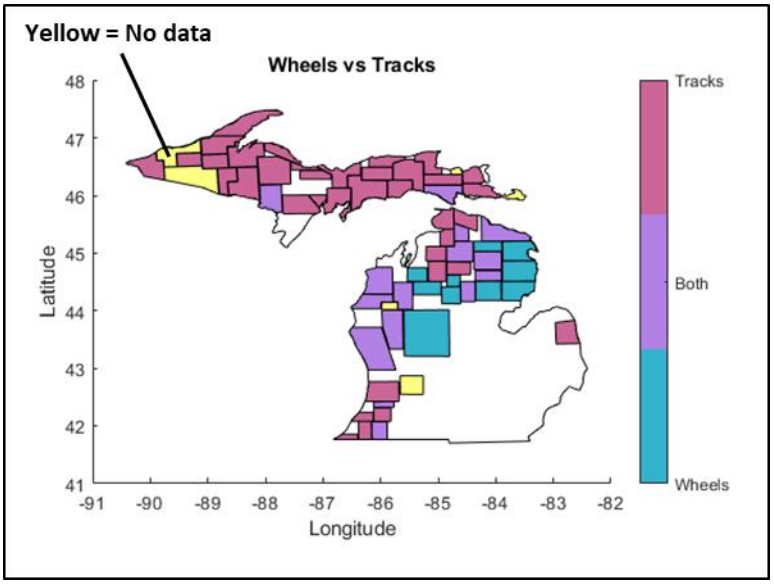

Figure 55. Location - Wheels vs Tracks

Figure 56 gives the breakdown of wheeled vs tracked groomers in the state.

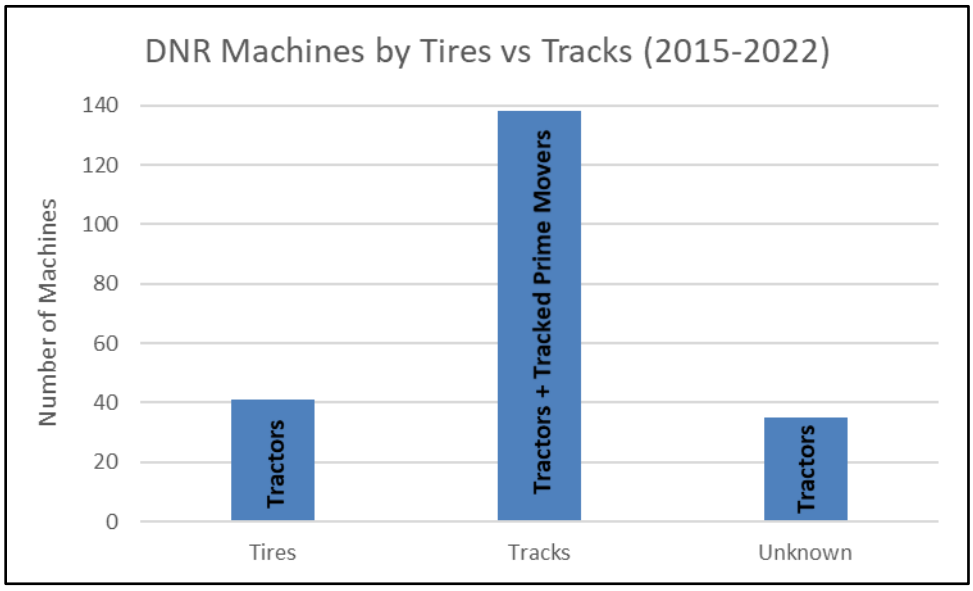

Figure 56. Numbers of Wheeled and Tracked Units

Figure 57 is a breakdown of costs for tires and tracks on the units that can be configured either way. The cost of track use is much higher than that of the wheeled units. This result contains the

cost of tracks, which is much higher than tires, but overall gives a good overview of the differences. While some areas cannot use wheeled groomers, any time tracks can be replaced by tires will show a significant cost savings. Keep in mind, however, that there may be some cost associated with stuck tractors and slowdown of grooming when unexpected heavy snow events occur in low snow areas.

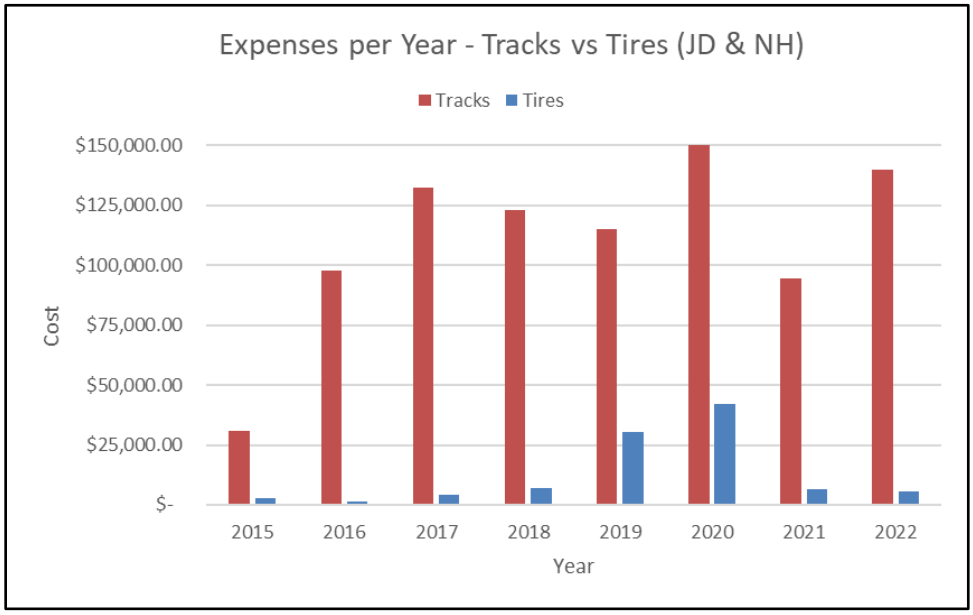

Figure 57. Expense - Tires vs Tracks

Figure 58 is a breakdown of the tractors in the program that run on tires.

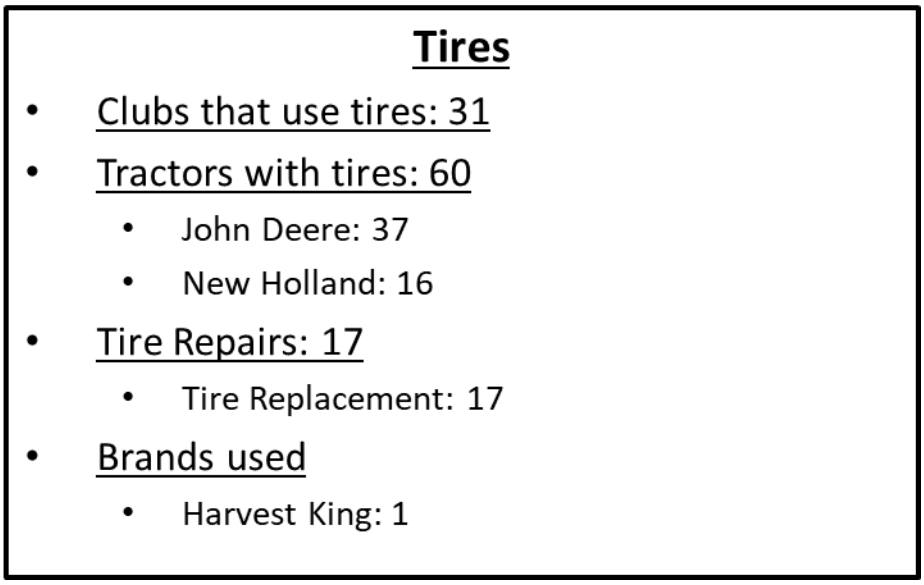

Figure 58. Tire Use Breakdown

Track repairs are the most common and costly repairs and replacements in the snowmobile program.

The most common tracks used on tractors are supplied by Soucy. These are tracks that are installed on wheeled tractors. John Deere tractors with factory tracks are the next most common. Surtrac tracks on New Holland tractors are being phased out, and there are a limited number of Zuidberg and Mattrack systems in use.

The tracked prime movers all have permanent tracks that are original to the unit.
Figure 59 gives a breakdown of the prime movers with tracks.

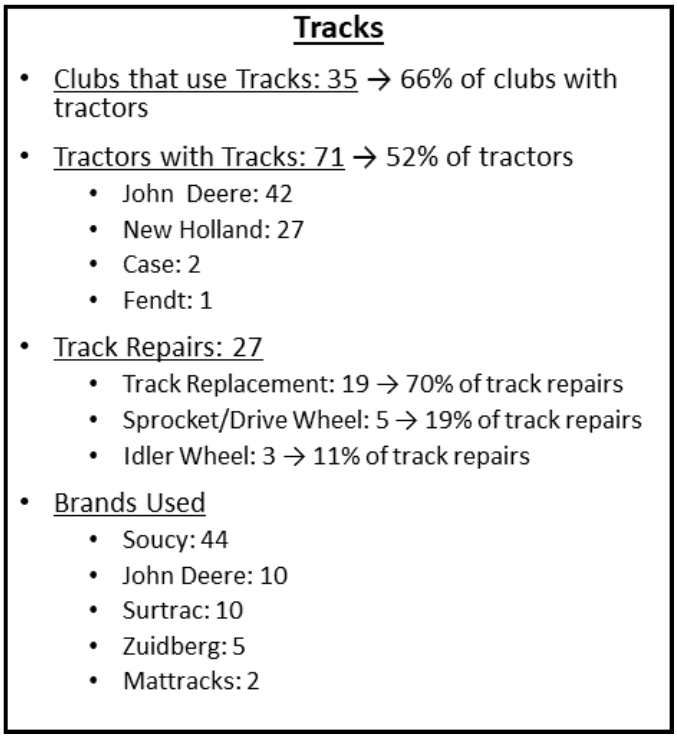

Figure 59. Clubs using Tracks

Wheeled Tractors

The data analyzed under this study indicates that track replacements occur on average at about 5 years on the wheeled prime movers with tracks. Figure 60 is a breakdown of the cost comparison between tires and tracks. The data clearly shows that tracks are much more expensive over the life of the unit than tractors run on tires.

Since there is not a lot of data for any track units besides Soucy, it is difficult to make any recommendations for different manufacturers. The use of others should be watch over the coming years to compare durability between the different types. Recommendations to prolong the life of tracks on tractors include making sure that track tensions are kept adjusted. Inspect idler wheels and sprockets on a regular basis. Grease as necessary. Keep ice and snow out of the tracks at the end of the day. Don't operate on bare ground.

There may be areas across the state that could use wheels instead of tracks. These clubs would have to be chosen on a case by case basis by looking at snowfall, terrain, amount of grooming on average, etc. There are a number of alterations to the tires that can help in the decision making. Tire studs or chains can be very helpful to increase traction and side slope stability. Studs do, however, cause pavement damage in some cases. The use of snow tires is also advantageous. Tires can be ballasted with liquids to increase load resulting in better traction. Duals can be used for flotation, but the loss of traction using this method usually makes this option unsatisfactory. Figure 61 gives some recommendations for tires, ballast, and traction aids.

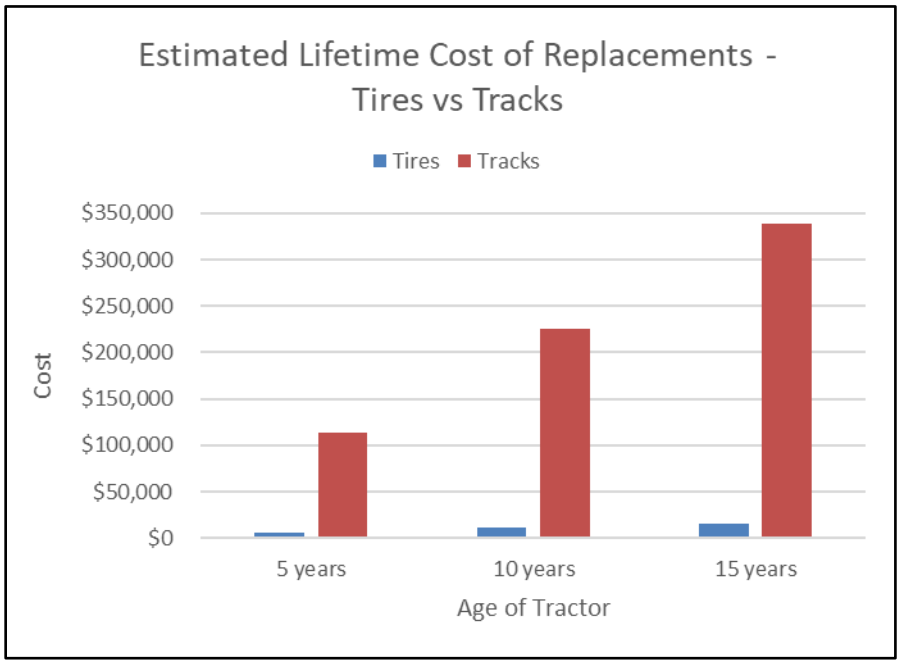

Figure 60. Replacement Cost - Tires vs Tracks

Figure 61. Tire Recommendations

Tracked Prime Movers

The data analyzed under this study indicates that track replacements occur on average at about 7 years on the tracked prime movers. Figure 62 shows the overall cost to the program for tracks on tracked prime movers.

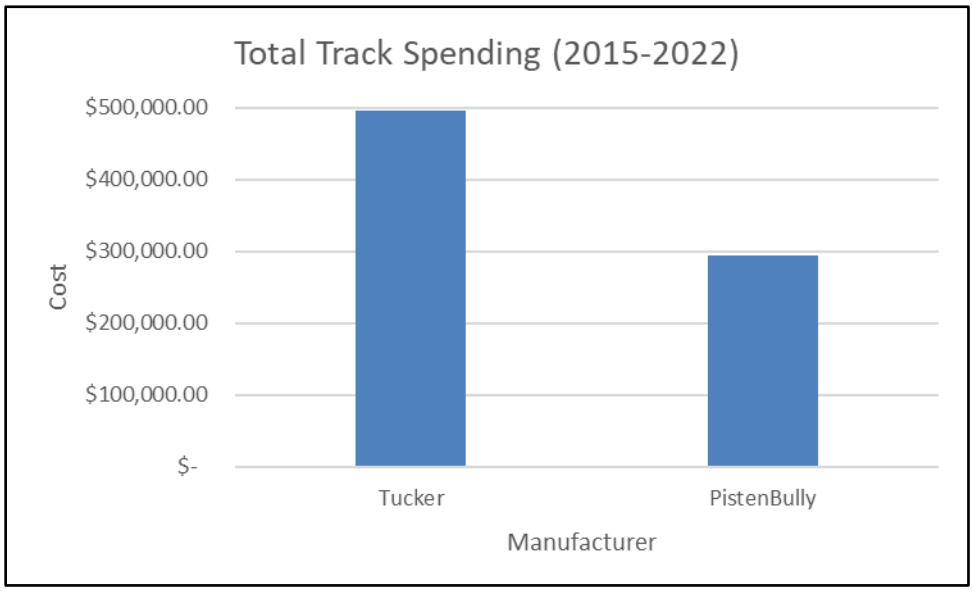

Figure 62. Track Cost - Tracked Prime Movers

Recommendations to prolong the life of tracks on tracked prime movers are essentially the same as for the track pods. Make sure that track tensions are kept adjusted. Inspect idler wheels and sprockets on a regular basis. Grease as necessary. Keep ice and snow out of the tracks at the end of the day. Don't operate on bare ground if possible.

Traction can be enhanced by addition of metal or nylon cleats. These add-ons add stress to the tracks, however. They are also damaging to pavements.and they are not normally used for this reason.

Tucker Idler Wheel Repairs

The failure and repair of idler wheels on Tucker tracks appears to be a fairly high cost item. There were 20 idler replacements over the study period. The average cost of these repairs was about $5000 and the repairs were made on average at about 2800 hours of running time.

It is recommended that the idlers get inspected and greased regularly.

Correlation Between Tracks and Other Repairs

In the previous sections, the correlation between the use of tires and tracks in terms of cost was made. As it turns out, there appears to be a further damage contribution from tracks to other components of the prime movers.

Figure 63 correlates the drivetrain repairs between wheeled and tracked tractors. It is clear from this figure that tracks are more damaging to drivetrains than wheels.

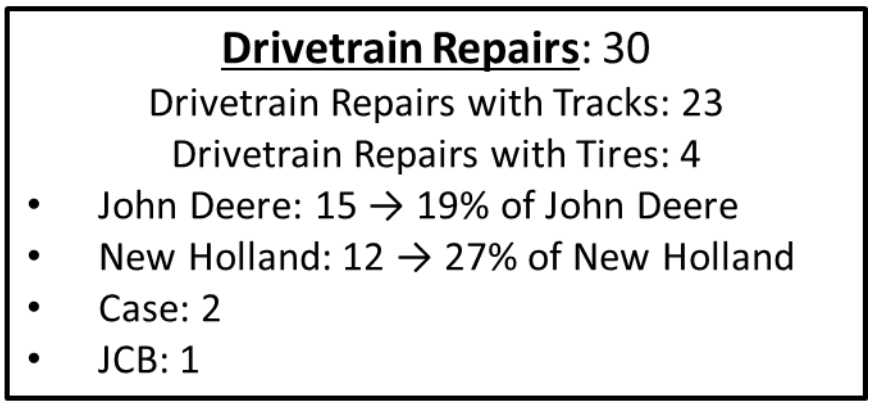

Figure 63. Correlation Tracks to Drivetrain Repair

.

Figure 64 is the correlation for engine repairs. It is not as clear for these repairs, but there are 33% more engine repairs for tracks than wheels for this study.

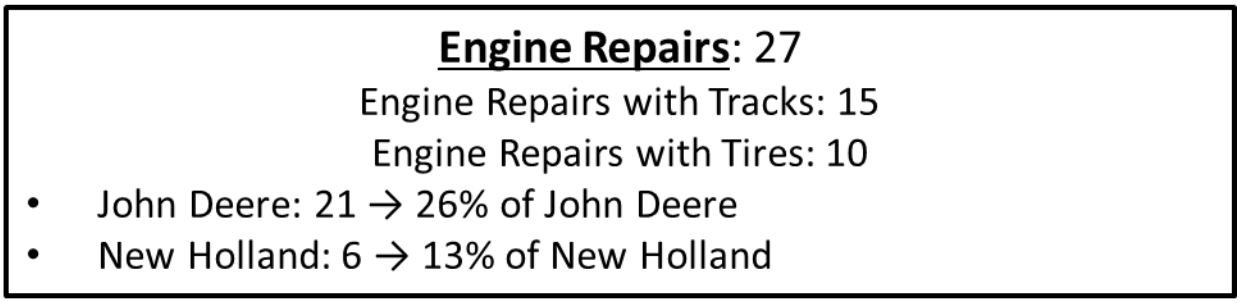

Figure 64. Correlation Tracks to Engine Repair

Correlation Between Different Models by Manufacturer

Figure 65 through Figure 68 are a breakdown of the number of repairs on prime movers by model. Since there are so many different models of tractors and not many individual units per model, it is difficult to make a comparison by either model or size. It can be seen from the figure that the sizes

are mixed throughout the comparisons from top to bottom. This is partly due to the fact that there may be only 1 or 2 units per model, and a single large repair skews the results considerably. In general, however, the larger units should be less prone to failures due to the harsh operation conditions that these tractors see. Repairs and operational costs are higher in the larger models, however.

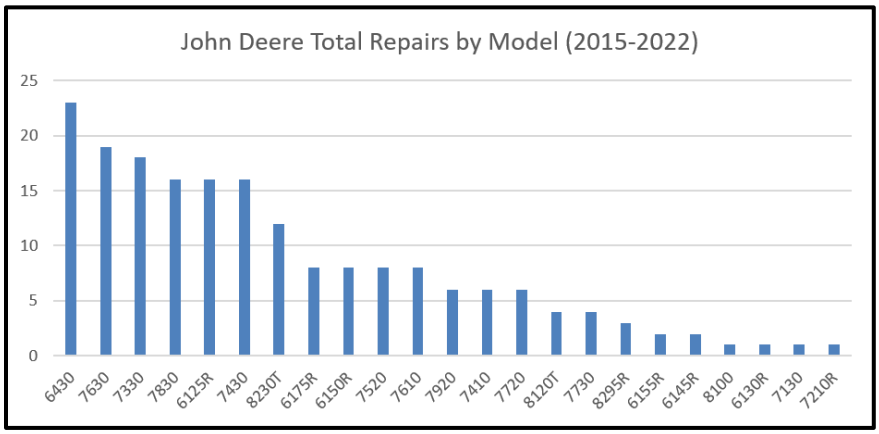

Figure 65. Repairs by Model - John Deere

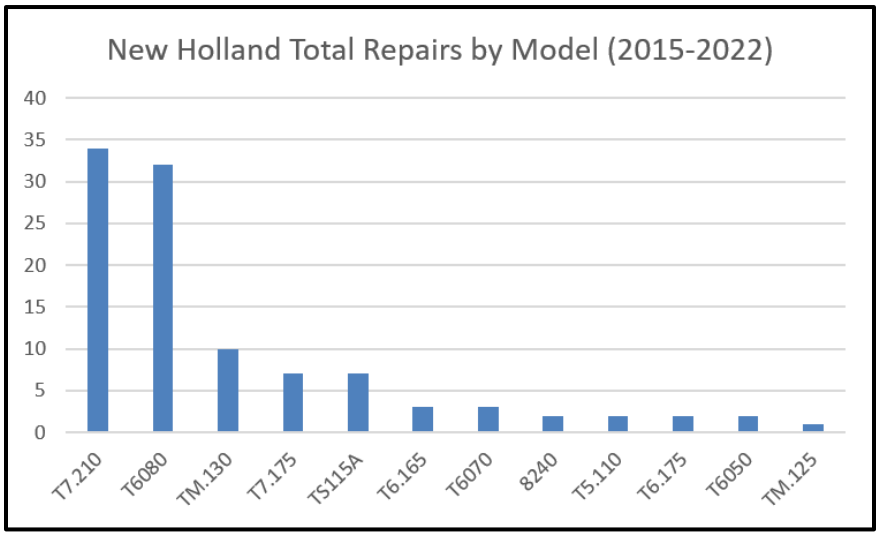

Figure 66. Repairs by Model - New Holland

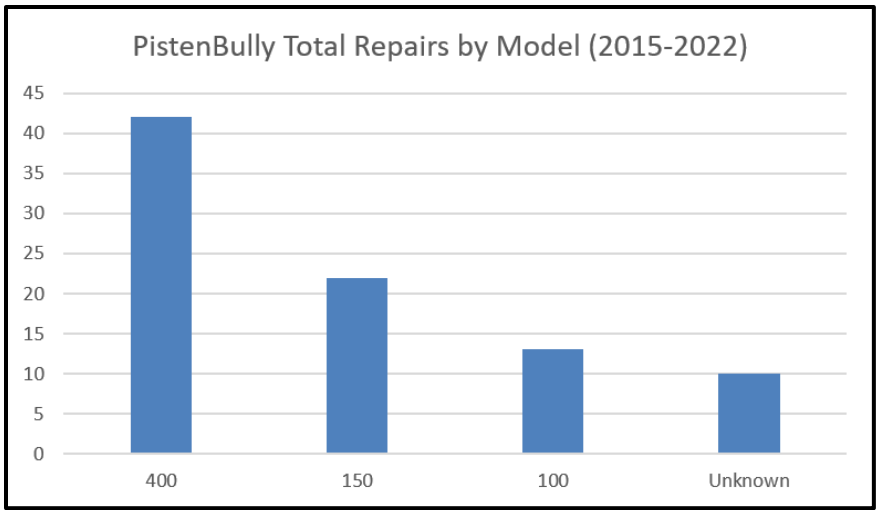

Figure 67. Repairs by Model - PistenBully

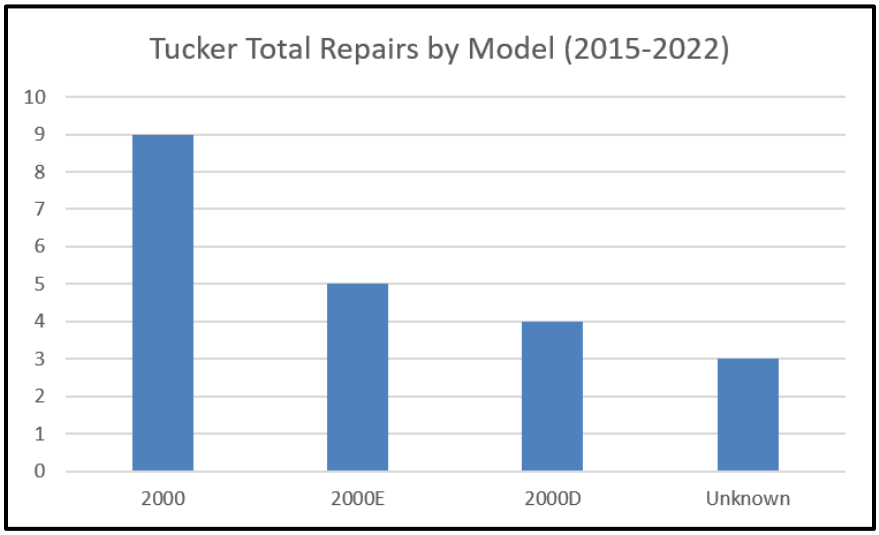

Figure 68. Repairs by Model - Tucker

Composite Cost Analysis for Prime Movers

Figure 69 and Figure 70 contain the 7 year cost for each of the 4 major prime movers including repairs. These also show the difference between wheels and tracks.

Tractors

(165 hp tractors with similar packages)

- John Deere
  - 6R 165 MSRP: $250,446
  - (Soucy GTX600: $108,685
  - Average Repair Cost Per Machine:
    - With Tires: $8,240
    - With Tracks: $27,592
  - **Total**
    - Tires: $258,686
    - Tracks: $386,723
- New Holland
  - MSRP (T7.210 AutoComm): $244,875
  - Tracks (Soucy 600GX 25/25): $108,685
  - Average Repair Cost Per Machine:
    - With Tires: $3,029
    - With Tracks: $32,675
  - **Total**
    - Tires: $247,904
    - Tracks: $386,235

Figure 69. 7 Year Cost - Tractors

Tracked Prime Mover

- PistenBully
  - 100 Trail MSRP: $289,000
  - 400 Trail MSRP: $318,000
  - Average Repair Cost Per Machine: $23,354
  - **Total**
    - 100: $312,354
    - 400: $341,354
- Tucker
  - 1100E MSRP: $215,000
  - 2000 Trail Boss MSRP: $295,000
  - Average Repair Cost Per Machine: $21,358
  - **Total**
    - 1100: $236,358
    - 2000: $316,358

Figure 70. 7 Year Cost - Tracked Prime Movers

OVERVIEW AND CONCLUSIONS

Data was made available for the grooming seasons of 2015/2016 through 2021/2022. This is not a long period for analysis, but the authors feel that it is sufficient to give a good snapshot of the repair and maintenance costs and issues present in the Michigan Snowmobile Trail Program. Since there is only a small number of manufacturers in the grooming industry, and there are only a limited number for each in the MI program, care must be taken when analyzing the data.

First, there doesn't appear to be major differences between manufacturers. It is probable, that there could be some extra equipment eliminated on some models that could save cost, but this is probably not a major cost savings.

Snowmobile trail grooming equipment is inherently put through some of the worst conditions that these units could see. They are driven long miles and run 7 days a week in most cases. For this reason, the condition of the trail base can be a major contributor to damage. Stumps, rocks, and obstacles can put excessive stress on the units whenever they are contacted and the groomer is jolted or even stalled. For this reason, fall trail maintenance can be quite beneficial. Try to keep tracked prime movers on the snow as much as possible.

There was no real smoking gun cost saver uncovered under this effort. The cost of tracks is obviously large, but the use of tracks is also needed for a large number of miles in the state. Maintenance is a huge factor in extending the life of the tracks. A standardized maintenance scenario for each club would be very helpful if it was possible. The authors realize that this is difficult in most cases because most clubs run with volunteers and variable crews. Being able to melt vehicles off daily or even weekly is huge. Ice and snow in tracks and running gear is hard on the units.

Driver training is also quite important. Again, volunteer groomers may not always be heavy vehicle operators.

Implementing daily operator reports would be helpful. These could simply be a daily sentence or 2 on a grease board that highlights any problems, noises, or issues. A daily checklist of items checked would be very helpful. Maybe post a maintenance schedule on the wall of the Club garage for each unit would be helpful to ensure that system checks are made daily, or at least weekly.

Better accounting of the repair and maintenance data would be very helpful. A log book containing all preventative maintenance as well as repair information, with accounting of the hours on the unit when maintenance occurred would be very helpful. Reports from maintenance personnel on what was broken and what was fixed would help also.