A Cost-Effectiveness Analysis: Using ArcGIS Online for Wisconsin USA Snowmobile Trail Maintenance Operations

Amanda Momeni
Department of Resource Analysis, Saint Mary's University of Minnesota, Winona, MN 55987

Keywords: Snowmobile Trail Maintenance, ArcGIS Online, Cost-Effectiveness, Association of Wisconsin Snowmobile Clubs (AWSC), Wisconsin DNR, Mapping Service

Abstract

Snowmobiling contributes a generous amount of revenue for the state of Wisconsin's tourism in the winter months. The trail system is managed by snowmobile clubs in every county. Currently all operations are performed without complete standardization between the counties and there is no digital data available in regards to the trail system, trail sign locations, bridges, or culverts. This study sheds light on the reality of moving trail maintenance operations to a digital format using ArcGIS Online. An online mapping application was created for the state and its counties to use as a place to track and regulate maintenance operations. The application was tested by a former Association of Wisconsin Snowmobile Clubs president and former Groomer King. After testing, a survey was issued to rate the performance of the application. Snowmobile fund income information was analyzed against the cost of an ArcGIS Online subscription and its benefits. All things considered, a subscription would be an affordable solution to moving trail maintenance operations to a digital platform.

Introduction

The state of Wisconsin boasts 25,000 miles of groomed snowmobile trails, ranking in the top three snowmobiling destinations in the U.S. (AWSC, 2012). The trail system contributes a significant amount of business to Wisconsin's winter recreation and tourism, from both residential and out-of-state riders (AWSC, 2012).

There are 72 counties in Wisconsin, each with varying miles of trail and clubs. Club volunteers maintain the trail system. In the fall, trail signs are posted along each mile of trail. During the winter months, trails are groomed by local snowmobile clubs. Each club has a Groomer King, who manages a group of groomers in the respective club and the machines used for grooming. In the spring, signs are taken down and stored until the fall (Momeni, 2014).

Wisconsin's trail program and snowmobile fund are controlled by the Wisconsin Department of Natural Resources (DNR). The Governor's Snowmobile Recreation Advisory Council offers advice and assistance to the DNR on certain matters regarding the program and funding. The program is funded by registration fees, sale of trail passes, and the state gas tax. Funds are spent on a priority basis required by Wisconsin state law. The priorities are listed in order below:

1. Existing Trail Maintenance
2. Club Signs

Momeni, Amanda. 2015. A Cost-Effectiveness Analysis: Using ArcGIS Online for Wisconsin USA Snowmobile Trail Maintenance Operations. Saint Mary's University of Minnesota University Central Services Press. Winona, MN. Volume 18, Papers in Resource Analysis. 12 pp. Saint Mary's University of Minnesota University Central Services Press. Winona, MN. Retrieved (date) http://gis.smumn.edu.

3. Bridge Rehabilitation
4. Route Sign Requests
5. Trail Rehabilitation
6. Development

Regular funding is based on the amount of trails groomed and hours spent grooming (priority #1). For a trail to be accepted as a part of the funded trail system it must be proposed to the county coordinator and then the county coordinator applies to the DNR for funding. Each mile of funded trail can earn up to $250 per year; however, in a "no snow year" the maximum funding amount may not occur.

Supplemental funding is received from the sale of non-residential trail passes and can only be applied for if a county exceeds its maximum funding (AWSC, 2010).

A groomer's wage is paid hourly based upon the class of machine driven – a monetary figure calculated by the DNR (AWSC, 2010). Hours grooming are logged by each groomer. The respective snowmobile club then submits its grooming hours to the county. The county then sends this information to the DNR to be processed and payment is received, which is then distributed to the groomers (Momeni, 2014).

The purpose of this study was to evaluate whether moving trail maintenance operations to a digital format with ArcGIS Online would be of value to snowmobile operations, in terms of record keeping and cost-effectiveness. Trail signs posted in the fall are not recorded in any format, digital or otherwise. Some counties have digital copies of their trail systems, but the majority does not.

ArcGIS Online provides subscriptions to their cloud-based platform (Esri, 2011). Utilizing this software would enable snowmobile clubs and the state to keep records of signage, bridges, culverts, and trail locations. In theory, the data would be entered and maintained by a representative of each county. Once each type of data was entered, maintaining the data would be considerably less each year because any changes to trail signs, bridges, culverts, or trails would be minor. The largest obstacle to begin the process of using ArcGIS Online would be initially conversion of paper-based information to a digital format. Another challenge is the differences in the scale of maps between counties and their standards of signage.

There are several goals to achieve in order for the application to be successful: Create digital data set for trails, signs, bridges, and culverts, make signing easier, improve communication, identify signs, bridges, and culverts needing replacement, ease of usability, correct signage, and to provide an affordable option. Each goal has indicators of success which will decide the effectiveness and feasibility of the application.

Study Parameters and Limitations

While Wisconsin record-keeping and financial records were used for the study, digital trail data was not available for testing the ArcGIS Online mapping application. As a result, digital snowmobile trail data was downloaded from the Minnesota Geospatial Commons website. As such, Winona County, MN digital snowmobile trail data was used as test data to evaluate the user-experience of the ArcGIS Online mapping application. As a result, references made to the ArcGIS Online mapping application is using similar data available in Minnesota and metrics referenced between the state of Wisconsin financial information and Winona County, MN mapping application test are not congruent. However, the study

focused on testing the mapping application for usability and overall experience without direct correlation to specific financial information.

Methods

ArcGIS Online Subscription

An ArcGIS Online subscription was registered as the application for snowmobile trail maintenance operations. Due to cost limitations, a 30-day trial subscription to ArcGIS Online was created and used as the timeframe of application access during the study.

Publishing the Maintenance Operations Application

The Winona County, MN boundary was used as the testing area for the online mapping application. Using Winona County as the testing area limited the number of trails required for inclusion. There are approximately 200 or more trails in the State of Minnesota. To make all of the trail names available as a list for user selection would have been too time consuming and unnecessary for testing the application. In the future, selecting a trail might occur by first selecting a county and then, based on the countyand then selecting from a list of trails.

In order to publish mapping services to ArcGIS Online, all feature classes were added to ArcMap. Before publishing the data, symbology was created and all aspects of the feature classes such as fields, subtypes, and domains were established.

The feature classes included in the Trail Maintenance application were the following:

1. MN snowmobile trails
2. Winona county boundary
3. Trail signs
4. Trail changes
5. General observations
6. Bridges
7. Culverts

There are 39 different types of signs, point features, used in this application. In order to provide clarity between the different types of signs, each sign was symbolized to look like the actual sign. For example, a stop sign point would show up as a stop sign icon.

Trail changes, displayed as line features, can be added to the map to represent areas where a trail might be better suited or needs to be moved based on land permission changes. Adding a line feature instead of changing the actual snowmobile trail itself enables the user to make one or multiple suggestions to be considered for approval or to show landowners where the trail change would be made.

General observations and point features were designed to be a place to record any type of comment or observation needing to be addressed or remembered. One example might be to place a general observation point where a cache of signs are kept in the field. Momeni (2014) stated sometimes caches of signs are left in the field for storage purposes. They are stored on a temporary basis and need to be retrieved before the snow falls. Signs are stored usually because there is no time in the day left to continue signing. Therefore, a cache is stored instead of being hauled back. Areas could also be labeled on the map where it would be safe to keep a cache of signs for storage. Another example of a general observation might be to mark areas where trees have fallen into the trail and needs to be removed.

Bridges, line features, were made available to keep track of their location and condition. This could be helpful when funding needs to be spent on bridge rehabilitation. A simple query could be run to find bridges rated "poor." Bridges rated poor would need rehabilitation first. Funding could easily be delegated by county based on the number of bridges in the county needing rehabilitation. Culverts were also included as a feature to keep track of their location and condition.

Assessing and Editing the Online Mapping Application

Doug Johnson, former president of the Association of Wisconsin Snowmobile Clubs (AWSC), and Kevin Momeni, former Groomer King, beta tested the application.

A tutorial guided the testers through the process of adding each feature available: trail signs, trail changes, general observations, bridges, and culverts. Figure 1 represents the screen a user would see once they had clicked the Edit button to begin editing.

On the left side of the screen, the Add Features section is where all of the editable features are stored. Simply clicking one of the features allows a user to add it to the map. Before or during editing, the basemap can be changed using the Basemap button located to the right of the Edit button. The application also allows users to create spatial bookmarks. Bookmarks could be useful on the county or state level to record any area needing to be addressed for any reason, which could then be viewed by anyone at any level.

The Measurement button allows users to measure squared units using a polygon or measure using a line for straight line distance. The Measurement tool might be useful to find the number of miles marked or yet to be marked with signs.

To the left of the Measurement button is a Directions button. Similar to the other online routing applications, entering a starting point and destination returns turn by turn navigation instructions. This feature may not be of great necessity to users, because snowmobile trails are not part of the roads system referenced by the Directions feature.

Printing is also an available option. Momeni (2014) and Johnson (2014) both commented on how this feature would be useful in multiple ways to the snowmobile clubs. One use could be to print a map of an area where trail changes were suggested. A landowner affected by a trail change would easily be able to see where the suggestion was made. Seeing the suggestion, with aerial imagery as context, would make it very clear to the landowner where the change was being made and/or a suggestion could be drawn on top of the printed map if the landowner had a different or better location for the change. Another use might be to print out the section of trails being signed by a volunteer group, ensuring the signs are placed correctly. The ability to see where signs are supposed to be would also ensure consistency and accuracy throughout the years.

Adding a Trail Sign

Figure 2 represents and addition of a trail sign. When a sign is added, a pop-up window gives the user a chance to add some information about the sign. Before publishing the map, subtypes were established to handle the four different kinds of signs used by snowmobile clubs: informational, regulatory, warning, and blazer.

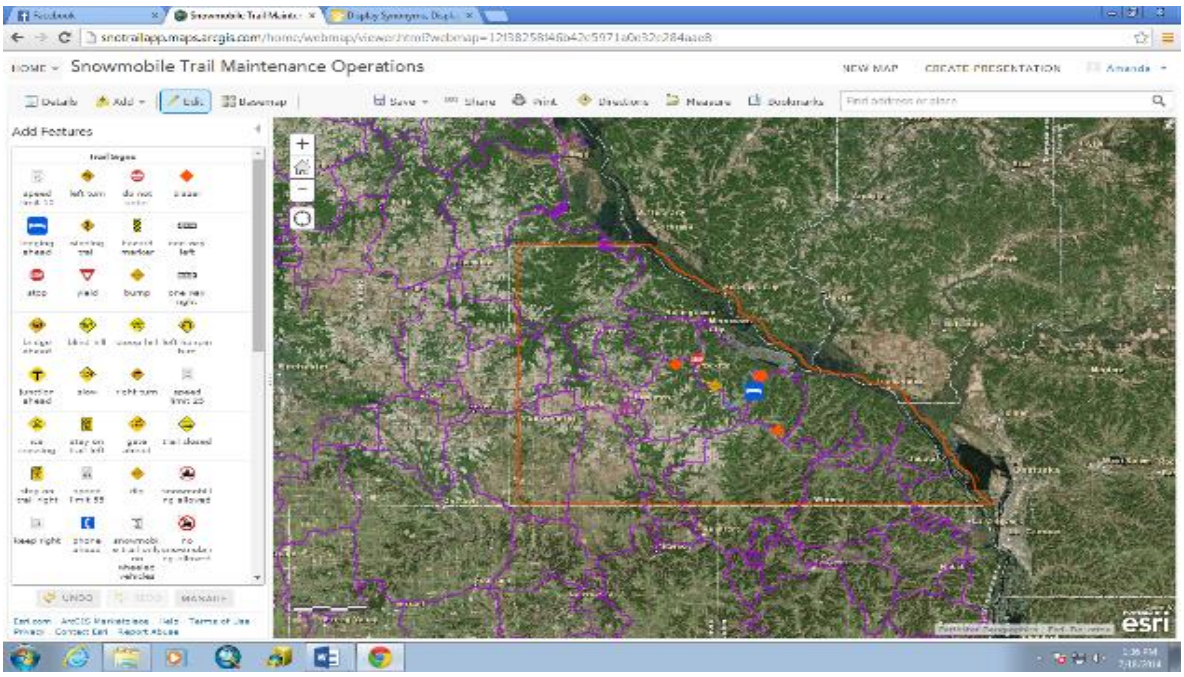

Figure 1. A sample screen view a user would typically see during an editing session.

Each subtype then had a domain containing all of the signs included in the subtype. The stop sign added in Figure 2 is an informational sign. The fields "Type" and "Sign_Des" (sign description) are populated automatically with "informational" and "stop," respectively, in response to the chosen stop sign point symbol. The user is then asked to enter the date it was placed. Trail names were also added as a domain to avoid user error.

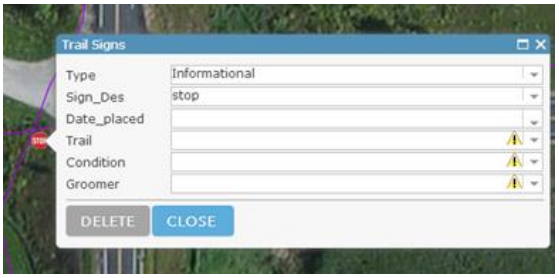

Figure 2. Stop sign pop-up window.

The choice list houses all of the available trails to choose from. If the user does not know the trail name, they may click on the trail segment to find out its name from the trail's information window and then return to complete the sign information. Domains were also established for Condition (poor, fair, good, and excellent) and for Groomer (by name). Figure 3 shows the completed stop sign data-entry window.

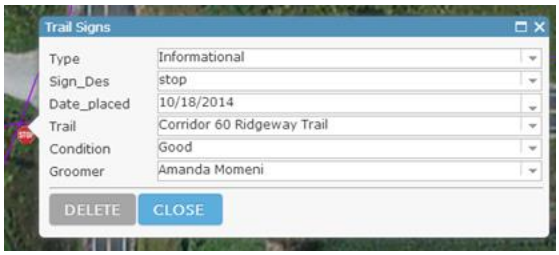

Figure 3. Completed stop sign pop-up window.

Adding a General Observation

Figure 4 represents the addition of a general observation. General observations are available for users to mark any specific point for any type of reason. The user is asked to enter a comment (observation), the date, groomer, and the trail. Some examples might be: a fallen tree blocking a trail and needing to be removed, erosion of a trail needs to be filled in, a cache of trail signs, etc. Figure 5 is the symbology

chosen for the general observation (magenta glasses).

Figure 4. Completed General Observation pop-up window for a fallen tree.


Figure 5. Symbology for a general observation.

Adding a Culvert

In the initial interview with Momeni (2014), culverts were a feature wanted in the application. Many culvert locations are not recorded. Maintaining culverts could be done more efficiently if the location and condition were recorded. Figure 6 represents the pop-up window for a culvert.

The user is asked to enter the trail name, a comment (if warranted), and the installation date. Unfortunately, the symbology for the culvert was not as easily visible in the application as anticipated (Figure 7).

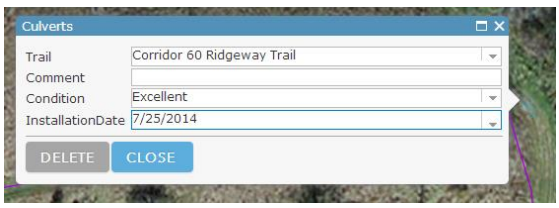

Figure 6. Completed culvert pop-up window.

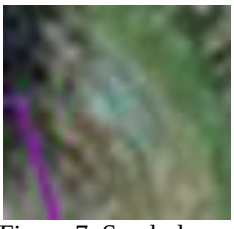
Figure 7. Symbology for culvert is the outline shape of a culvert releasing water in a light blue color.

Adding a Trail Change

A trail change is symbolized as a yellow line and the original trail is a purple line (Figure 8). A line is added to the map through a series of mouse-clicks. Each single click adds a vertex and a double click completes the line. The pop-up window for a trail change asks the user to provide the trail name, the groomer, the reason for the suggestion, and the date.

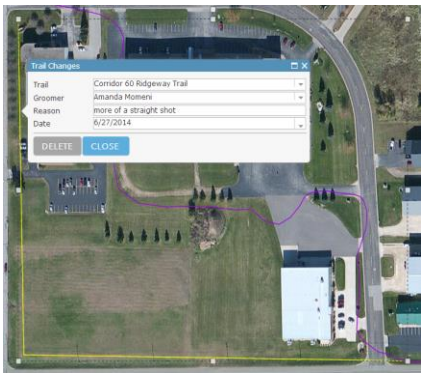

Figure 8. Suggested trail change (yellow).

Adding a Bridge

Like a trail change, bridges (red) are added to the map as a line feature (Figure 9). They are meant to be drawn directly on top of the trail. The user is asked to enter the trail, the condition, installation date, and comment if necessary. This example's comment reads, "3 boards need replacing." A field for recording these types of comments would be helpful to guide funding to any bridges/counties in need of maintenance, which is the third priority of the snowmobile fund.

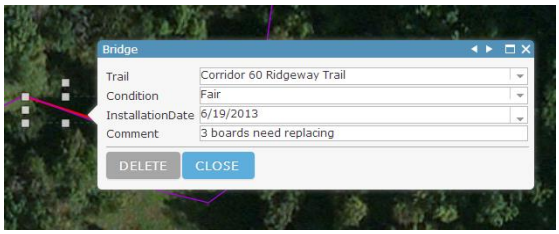

Figure 9. Completed pop-up window for a bridge.

Beta Test

Survey Questions

Following the beta test, a survey was issued to Momeni (2014) and Johnson (2014) to evaluate the performance of the application. The questions were constructed based on a framework for usability measurement (Bevan, 2009a), the seven dialogue principles of a dynamic system (Oppermann, 2002), user needs and requirements (Kauppein, Kujala, and Rekola, 2001), and the concept of user experience (Bevan, 2009b). The following are the questions from the survey divided into operational groups: Functionality, Usability, and Feasibility.

Functionality

1. Which features did you find to be of most value (check all that apply) (Table 1)?
2. What feature do you think would be the most valuable part of the application in terms of trail maintenance?
3. What was your favorite part?
4. Do you think this is a valuable tool?
5. Can you see this being used in the future? Why or why not?

Usability

1. How would you rate the ease of use 1-10 (1 being difficult to use, 10 being a piece of cake)?
2. Is it useful to have the signs symbolized like the actual sign you post?
3. Did you find anything confusing or difficult to understand about the application?
4. Is there anything you would change?

Feasibility

1. Do you believe the Association of Wisconsin Snowmobile Clubs would be behind this type of technology? Why or why not?
2. Do you believe the Wisconsin State DNR and tourism board would be behind this type of technology? Why or Why Not?
3. Could you see funding being spent on a subscription to implement this kind of technology?

Results

Survey results and a cost-effectiveness analysis were qualified and quantifed. The cost-effectiveness analysis uses goals of the application and its indicators of success to establish measures of effectiveness. Next, the Snowmobile Fund Income was analyzed comparing the income of the 2009-2010 season to the predicted income of 2015 with new legislation. A final analysis was conducted comparing the Snowmobile Fund Income with an ArcGIS Online one-year subscription to illustrate the percentage of Snowmobile Fund Income needed to purchase a subscription.

Survey Response Summary

Functionality

Both respondents found all features to be of value (Table 1). One respondent commented on how being able to print

trails marked with correct signage would be valuable to provide to people who are marking the trails.

Table 1. Responses to Functionality survey question 1. The "x" mark represents a positive response to the feature being valuable.

x	Trail Signs	x	General Observations
x	Trail Changes	x	Basemaps
x	Bridges	x	Print
x	Culverts		

The most valuable features indicated by the respondents were the ability to reroute trails utilizing different basemaps, especially imagery and the ability to see precisely which signs are placed where. The aerial view was one respondent's favorite part of the application, while the other respondent's favorite part was the ability to plan and carry out proper trail sign placement.

Comments regarding the application's use in the future highlighted the differences between the generations involved in the process. Comfort with online applications varies, and that may affect its use.

Usability

Neither respondent found the application to be confusing or the need to change anything. The ease of use, based on a 1-10 (10 indicating very easy) scale, resulted with scores of a 9 and an 8. Both respondents found the trail signs symbolized as one would see them in the field to be very useful. The term "easy" in the question was defined as a means of someone with little to no computer literacy.

Feasibility

When asked if the AWSC would be in support of this type of technology being used, both respondents expressed how they thought there would be no reason for them not to. When asked if the Wisconsin DNR and the Wisconsin tourism board would be in favor of implementation, one respondent said it would be a valuable time saver for them and the other respondent said it would enhance the safety and use of trails and saw no reason why the two would not be in favor.

Finally, in relation to funding being spent on a subscription, the respondents suggested if usefulness and cost-savings and usefulness were shared, support would be encouraging.

Cost-Effectiveness Analysis

A cost-effectiveness analysis (CEA) for this study is more appropriate than a cost-benefit analysis (CBA) simply because the majority of the benefits are intangible. A CBA assigns monetary values to benefits. In contrast, a CEA considers the key outcomes/benefits and costs of a program without using a monetary value. The value is instead thought of in terms of measures of effectiveness (Cellini and Kee, 2010). Both a CBA and a CEA use a cost-benefits table for analysis (Table 2)

Table 2. A Cost-Benefits table for the ArcGIS Online mapping application.

Costs
1. ArcGIS Online Subscription
2. Employee to create and maintain system
3. Increased responsibility for county worker
Benefits
1. Improved communication
2. Safety
3. Time saved signing
4. Time saved identifying areas of concern
5. Identifying bridges or signs needing replacement quickly
6. Accurate mileage recorded

Measures of Effectiveness (MOE)

To measure the effectiveness of moving maintenance operations to ArcGIS Online, goals and indicators of the success of those goals were identified (Table 3).

Table 3. Goals and indicators of goal success.

Goals	Indicators of Success
Create digital data set for trails, signs, bridges, and culverts	○ All trails, signs, bridges, and culverts are included ○ All counties participate
Make signing easier	○ Less confusion about sign location ○ Trails signed quicker (time saved)
Improve communication	○ Consistency and accuracy between users, year to year ○ Standards of signage are consistent between clubs and/or counties ○ DNR distributes funding appropriately based on priorities
Identify signs, bridges, and culverts needing replacement	○ Queries locate features needing replacement or attention ○ Replacements are made quickly and effectively
Usability	○ Reported comfort of use ○ Application used correctly
Correct Signage	○ Improved safety ○ Less accidents
Affordability	○ Cost % of budget

Snowmobile Fund Income

To evaluate whether or not the snowmobile fund had enough money available to purchase a subscription, the income of the fund was analyzed. Table 4 represents the income of the snowmobile fund for the year 2009-2010 (winter to spring).

Table 4. Income of Wisconsin Snowmobile Fund 2009-2010 (AWSC, 2010).

Type of Income	***Details***	***2009-2010 Income***
Number of Registrations (226,152)	Cost of Registration ($15)	$3,392,280
Gas Tax	50 Gallons @ 30.9 Cents per Registration (226,152)	$3,494,048
40% Tourism Factor	40% of Gas Tax	$1,397,619
Non-Resident Passes (27,648)	Cost of Passes ($35)	$967,680
Total		$9,251,627

Where the Money Goes

The income collected from registration, gas tax, and trail passes funds more than just the snowmobile fund (trail maintenance). There are several uses for the money, such as the snowmobile safety course, training and enforcement for safety courses, county law enforcement, DNR staff, registration, and aids of administration (AWSC, 2010). However, the majority, approximately 78%, is spent directly on trail aid.

Predicted Income for 2015-2016 Season

New legislation passed in 2014 will affect the revenue of the snowmobile fund for 2015-2016 (Table 5). Effective July 1, 2015 registration costs will change from $30/2 years to $30/3 years. All registered snowmobiles will also need to purchase a WI trail pass. The cost of the trail pass for WI residents will be affected by their membership to a snowmobile club and to the AWSC. Residents who are members of both a snowmobile club and the AWSC will receive a discounted trail pass at $10. Residents not holding a membership will be charged $30. This new piece of legislation was passed in an effort to encourage people to become members of snowmobile clubs and the AWSC (AWSC

and Wisconsin DNR, 2014).

Non-resident passes will also see an increase from $35 to $50. Non-resident passes are not affected by a person's membership to any club or organization in their home state (AWSC and Wisconsin DNR, 2014).

Table 5 was calculated based on the new legislation and used the most recent numbers available to predict the income for the 2015-2016 season.

Table 5. Predicted Income of Wisconsin Snowmobile Fund 2015.

Type of Income	***Details***	***2015 Predicted Income***
Number of Registrations (220,632)	Cost of Registration ($10)	$2,206,320
Gas Tax	50 Gallons @ 30.9 Cents per Registration (220,632)	$3,408,765
40% Tourism Factor	40% of Gas Tax	$1,363,506
Resident Passes (Members Only)	Member of club and AWSC ($10) (2013 membership 24,782)	$247,820
Resident Passes (Non-Members)	Not member of club or AWSC ($30) (registrations – memberships above = 195,850)	$5,875,500
Non-Resident Passes (27,648)	Cost of Passes ($50)	$1,382,400
Total		$14,484,311

For registration income, the number of registrations was calculated using the average number of registrations from 2002-2013 (AWSC, 2012). The gas tax is regulated by the state and remains constant at 30.9 cents. The tourism factor is 40% of the Gas Tax income. Resident pass income calculations were divided between members (snowmobile club and AWSC member) and non-members. The AWSC membership number for 2013 was used to calculate the income from member trail passes. This number assumes all members of the AWSC are also members of a snowmobile club. The non-membership income was calculated by subtracting the number of AWSC members in 2013 from the average number of registrations. The income from non-resident passes uses the number of passes sold during the 2009-2010 season, from Table 4.

Comparing Table 4 and Table 5 reveals a great increase in revenue due largely to the sale of resident passes to members and non-members. The increase in income from 2009-2010 to 2015-2016 was $5,232,684. This number assumes the membership of snowmobile clubs and AWSC does not change in conjunction with the new legislation. If the legislation works in the way it was intended and more people become members to receive the trail pass at a reduced cost, the predicted income has the potential to decrease.

Purchasing an ArcGIS Online Subscription

ArcGIS Online subscriptions are offered as three different plans. The plans are based on the number of users and credit use. The number of users for each plan is 5, 50, and 100 (Esri, 2014). Because there are 72 counties in Wisconsin, and this study assumes a worker from each county will maintain the data for its respective county, the subscription plan would need to be the option with 100 users. This plan offers 17,500 credits and costs $17,500 for a one-year subscription (Esri). Credits are based on the type of services used by the

application. The snowmobile trail maintenance operations application uses very basic services which do not consume credits as quickly as applications using intensive processing tools.

The application would likely be purchased by the DNR because they are responsible for the snowmobile fund. This study assumes the WI DNR does not currently have a subscription to ArcGIS Online already.

A final analysis was to calculate the percentage of an ArcGIS Online subscription ($17,500) cost relative to the 2009-2010 and 2015 projected incomes (Table 6).

Table 6. Income percentage of ArcGIS Online subscription ($17,500) for years 2009-2010 and 2015.

Year	Income	% of Income
2009-2010	$9,251,627	0.189
2015	$14,484,311	0.120

Discussion

The survey results show promise for the application's success. However, there are details that could have been overlooked based on how the application would truly be implemented.

In terms of initially gathering the data, an avenue worth exploring is having the application be used on a mobile device in the field. The initial marking of sign placement could be made easier if the application was mobile. However, a mobile phone or tablet capable of using the application could prove to be difficult in certain areas because of reception difficulties. A GPS device might be needed to record all locations, however even GPS is subject to reception issues. It could be difficult to coordinate the clubs and counties in an effort to collect the data. Along with the use of GPS is the question of where a GPS device would come from. Would the county need to buy a unit? Would the state provide one? Could a unit be borrowed?

Also, it is not certain whether the WI DNR would be the one to purchase the subscription or if they currently hold one. If they do currently have a subscription, would it be possible to add users to their plan?

One piece of data requested to be a part of this application in the initial interview with Momeni (2014) was parcel/landowner data. Momeni explained how when a trail need to be relocated it would be helpful to know who to speak to. Parcel data was not a part of the application because the data was not available. Its addition could increase the applications usefulness and success.

Changing the symbology for the general observations and culverts would need to be addressed if the application was developed for actual use. The current symbology for these items is difficult to see. More appropriate and visible symbols should be chosen.

Additional testing of the application could shed light on different areas of improvement or additional features. It would be ideal to test the application with the volunteers who post the trail signs out in the field. In addition to testing the application itself, a map of signs already plotted and printed to use as a guide could be tested as well.

Conclusions

Snowmobile trail systems and their maintenance are inherently spatial. ArcGIS Online provides an easy to use platform allowing even a non-GIS professional to explore spatial solutions and utilize mapping services.

The benefits for developing this

application do potentially outweigh the costs. With a predicted increase in revenue of roughly $5,000,000, and the small percentage of income a subscription would cost, the snowmobile fund should be able to sustain a subscription to ArcGIS Online.

Acknowledgements

I would like to thank Kevin Momeni and Doug Johnson who participated in multiple face-to-face and phone interviews. Their insights helped me to focus and fine tune my efforts toward making this study a success.

References

AWSC. 2010. Association of Wisconsin Snowmobile Clubs. Funding the Snowmobile Program. Retrieved April, 2014 from http://www.awsc.org.

AWSC. 2012. Association of Wisconsin Snowmobile Clubs. Wisconsin Landowners & Snowmobilers. Retrieved April, 2014 from http://www.awsc.org.

AWSC and Wisconsin DNR. 2014. Change is Coming. Retrieved June, 2014 from: http://www.awsc.org.

Bevan, N. 2009a. Extending quality in use to provide a framework for usability measurement. In *Human Centered Design* (pp. 13-22). Springer Berlin Heidelberg.

Bevan, N. 2009b. What is the difference between the purpose of usability and user experience evaluation methods. *EXAM 09 Workshop, INTERACT*.

Cellini, S. R., and Kee, J. E. 2010. Cost-effectiveness and cost-benefit analysis. In *Handbook of Practical Program Evaluation* (pp. 493-530). San Francisco, CA: Jossey-Bass.

Esri. 2011. Why Use Cloud Infrastructure for ArcGIS. *ArcNews Online*, Summer, 2011. Retrieved April, 2014 from http://www.esri.com/news/arcnews/summer11articles/why-use-cloud-infrastructure-for-arcgis.html.

Esri. 2014. Pricing. Retrieved June, 2014 from http://www.esri.com/software/arcgis/arcgisonline/purchase.

Johnson, D. 2014. [Personal interview]. Amery, Wisconsin.

Kujala, S., Kauppinen, M., and Rekola, S. 2001. Bridging the gap between user needs and user requirements. *Advances in Human-Computer Interaction I (Proceedings of the Panhellenic Conference with International Participation in Human-Computer Interaction PC-HCI 2001), Typorama Publications* (pp. 45-50).

Momeni, K. 2014. [Personal interview]. Amery, Wisconsin.

Oppermann, R. 2002. User-interface design. In *Handbook on information technologies for education and training* (pp. 233-248). Springer Berlin Heidelberg.