LINKING FOREST SCIENCE TO POLICY: IMPROVING A FOREST INDICATORS DASHBOARD TO INFORM POLICY AND DECISION MAKING ACROSS VERMONT'S FORESTED LANDSCAPE

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Linking Forest Science to Policy: Improving a Forest Indicators Dashboard to inform policy and decision making across Vermont's forested landscape

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Last Updated June 1, 2019.

ACKNOWLEDGMENTS

EXECUTIVE SUMMARY

The Vermont Forest Indicators Dashboard was developed to aggregate a wealth of environmental, economic and abiotic data in order to better understand and monitor the condition of Vermont's complex forested ecosystems, provide a long-term context for any changes witnessed, and inform the development of policy, regulations, and management activities to sustain this critical resource. While the scientific inquiry, data collection, and tool development have been completed, additional efforts were need to maximize utility, increase visibility and engage the stakeholders who may best utilize the information it provides. Support from the Jeffords Fund Grant allowed us to engage key legislators, decision makers, and government officials to identify a set of activities and improvements to increase the policy relevance, accessibility, and awareness of the Dashboard. Our efforts focused on conducting one-on-one interviews with key stakeholders to serve three goals: (1) identifying stakeholder needs currently met and unmet in the current tool, (2) identifying potential use cases for the Dashboard on current policy and decision support issues, and (3) expanding visibility and utilization of the tool among potential users. In addition to direct contact with key stakeholders from non-profit, planning and advocacy organizations as well as state and federal agencies, we also presented the Indicators Dashboard to various professional groups to expand awareness and solicit feedback, as well as presented the tool at professional meetings. Through this outreach we identified and completed a number of substantive changes to the Dashboard, and have identified additional features for development that will be implemented in the coming months, as we concurrently launch versions of the Forest Indicators Dashboard requested by state officials in New York and New Hampshire. Specific uses of the tool identified by stakeholders include using the Dashboard to identify critical or emerging issues and determine advocacy goals, monitoring and assessing how well the state is doing at achieving conservation and stewardship goals, and providing rapid communications and visualizations to present to legislators and land managers to support decision and policy making activities. Stakeholder feedback indicate that the Dashboard fills an important information gap, and that with the changes identified and implemented as a part of this project, it will be even more relevant for those working in forestry policy, advocacy, management, and planning. The resulting version of the Indicators Dashboard will be presented to the Vermont Senate and House of Representatives at the beginning of the 2020 legislative session to further expand awareness and utilization of this tool to support their decision-making regarding Vermont's forests.

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INTRODUCTION AND JUSTIFICATION

For many years, officials from the Vermont Agency of Natural Resources have advocated for a scientifically robust way to monitor and assess the quality and condition of Vermont's forested landscape. They cited the need for such information to help direct policy conversations, inform management, and identify emerging threats to this critical state resource. In response to this need, the Forest Ecosystem Monitoring Cooperative (FEMC)[1], a regional collaborative funded by the USDA Forest Service, the Vermont Agency of Natural Resources and the University of Vermont Rubenstein School of Environment and Natural Resources, worked with scientific experts and stakeholder groups to identify a set of indicator variables designed to capture the current condition and long-term trends in the condition and structure of Vermont's forested ecosystems, as well as the services they provide to Vermont residents, economic viability, and the many stress agents they face.

Synthesizing these long-term data sets has resulted in the development of the Vermont Forest Indicators Dashboard, available online at https://www.uvm.edu/femc/indicators/vt. This data-driven ecological monitoring tool, informed by experts, quantifies the long-term structure, condition, services and severity of stress agents on Vermont's forests in simple terms to offer a holistic view of our forests. It is regularly updated as new data is collected and aggregated into an overall metric quantifying the health of the state's forested ecosystems. Individual datasets can be visualized and explored, current forest condition and long-term trends can be compared to target values, and strengths, vulnerabilities, and emerging threats can be identified.

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[1] http://www.uvm.edu/femc/
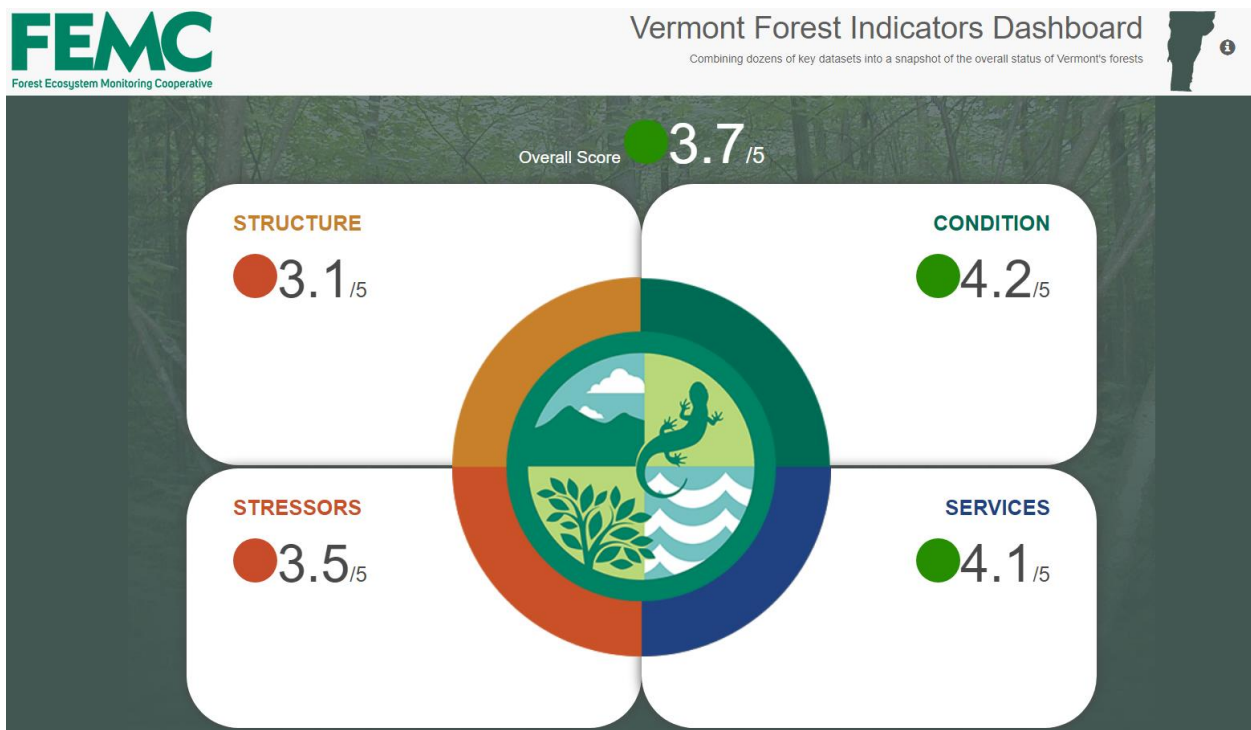
The use of similar "indicator" tools has become more widespread as policy makers and land managers struggle to understand the impacts of multiple interacting environmental stressors on the natural resources they are charged with protecting, and the increasing availability of data sets to assess these conditions. This is particularly true within federal agencies, where quantitative metrics are required to guide and assess the efficacy of new policies, regulations or management activities, such as with the Environmental Protection Agency's Risk Screening Environmental Indicators Dashboard[2].

The Vermont Forest Indicators Dashboard was developed with a similar intent – to be utilized by legislators, decision-makers, educators, and the general public to aggregate a wealth of environmental, economic and abiotic data in order to better understand and monitor the condition of Vermont's complex forested ecosystems, provide a long-term context for any changes witnessed, and inform the development of policy, regulations, and management activities to sustain this critical resource. While the scientific inquiry, data collection, and tool development have been completed, additional efforts were needed to improve and refine the tool with input from stakeholders who may best utilize the information it provides.

To address this need, we utilized support from the James M. Jeffords Fund Grant Program for Policy Studies to engage key decision makers, and government officials to identify a set of activities and improvements to increase the policy relevance, accessibility, and awareness of the Dashboard. This included developing new functionality, visualization and information content in order to support the needs of policy makers, advocates, and professionals involved in setting priorities for Vermont's forested ecosystems.

APPROACH

To identify needed improvements to the Vermont Forest Indicators Dashboard, we proposed the following steps:

- Conduct research on audience needs to make the Dashboard more policy relevant,
- Deploy new features identified as priority stakeholder needs,
- Develop use cases to exemplify the utility of the Dashboard,
- Hold two workshops specifically targeting policy-makers around key forest health issues identified by the Dashboard, and
- Conduct outreach to a broader audience of potential users of the Dashboard.

After further analysis of the participants and the types of input we needed to identify needed improvements, we decided to focus our information gathering effort on conducting one-on-one interviews with key informants to serve three of our goals: (1) identifying stakeholder needs, (2) identifying potential use cases for the Dashboard, and (3) expanding visibility and utilization. More information on interview methodologies is provided below. We were also able to deliver presentations on the Vermont Forest Indicators Dashboard at several professional meetings, both to seek additional feedback and to market the existence and utility of this tool.

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[2] https://edap.epa.gov/public/extensions/EasyRSEIv236/EasyRSEIv236.html

Key Informant Interviews

We set out to interview people from each sector that we identified as having a role in forest legislation, advocacy, policy, or management in Vermont. This included people from local, state, and federal levels of government as well as people from the non-profit advocacy sector (Table 1). Informants were asked a standard set of open-ended questions (Appendix 1). Responses were then coded and summarized in the outcomes described below.

Table 1: Sectors, organization/agency/group, and people we identified as having a role in Vermont forest legislation, advocacy, policy, and/or management. Note that not all interviewees identified here were able to participate. Those who were unable to be interviewed are depicted with a footnote. Also note that some interviewees represented more than one organization/agency.

Sector	Organization or Agency	Interviewee
Local	Regional Planning Commissions/ Vermont Association of Planning and Development	Clare Rock, Chris Campany, Tasha Willis
State	Vermont Housing and Conservation Board	Jennifer Hollar, Hannah Phillips
	Vermont Department of Environmental Conservation	Rebecca Ellis
	Vermont Fish and Wildlife Department	Bob Zaino
	Vermont Forest, Parks, and Recreation Department	Danielle Fitzko, Michael Snyder
	Vermont House Natural Resources, Fish and Wildlife Committee	Amy Sheldon[a]
	Vermont Senate Natural Resources and Energy Committee	Christopher Bray[a]
	Vermont House Agriculture and Forestry Committee	Carolyn Partridge[a]
	Vermont Senate Agriculture Committee	Robert Starr[a]
Federal	USDA Forest Service Green Mountain and Finger Lakes National Forests	Jay Strand
Non-profit	The Nature Conservancy	Phil Huffman
	Vermont Family Forests	David Brynn
	Vermont Natural Resources Council	Jamey Fidel

[a] Unable to interview

OUTCOMES

Through this work, we made a number of contacts in a variety of settings to identify needed improvements on the Forest Indicators Dashboard as well as promote awareness and use of this tool.

We interviewed 13 key informants from non-profit, planning and advocacy organizations as well as state and federal agencies (Table 1). In addition to one-on-one interviews, we delivered a poster at the Forest

Ecosystem Monitoring Cooperative's annual conference (Pontius et al. 2018) and presented information about the Dashboard and its utility to three groups:

- The Vermont Urban and Community Forestry Council, which advises the Vermont Urban and Community Forestry Program staff on implementation of the program, with an estimated 20 attendees,
- The Vermont Forest Roundtable, a venue for the exchange of information on forest conservation and convened by the Vermont Natural Resources Council, with an estimated 25 attendees, and
- The quarterly meeting of the Regional Planning Commissions, which assists member municipalities in addressing regional issues and providing effective local governance, with an estimated 25 attendees.

We will work with Mike Snyder, the Commissioner of the Vermont Department of Forests, Parks and Recreation, to schedule time in the 2020 legislative session to introduce and expand use of the Dashboard directly in a policy formulation setting.

Finally, we have identified and completed a number of substantive changes to the Dashboard, and have identified additional features for development that will be implemented in the coming months, as we concurrently launch versions of the Forest Indicators Dashboard for New York and possibly New Hampshire.

Below, we describe general findings from our interviews along with specific use cases of the Dashboard that were provided by interviewees.

General Findings

People working in forestry-related fields have many different needs and uses for data describing the condition of Vermont's forests. These interviews demonstrated a number of these differences, but they also highlight needs that span across disciplines and sectors and that the Vermont Forest Indicators Dashboard provides. The following findings indicate that the Dashboard fills an important information gap, but that with certain changes, it will be even more relevant for those working in forestry policy, advocacy, management, and planning.

WHAT WORKS WELL

A great majority of people we interviewed found the long-term data trends interesting and predicted they would be useful. The predicted utility of the trends, and the Dashboard as a whole, is discussed later in this report. For several people, having a single website where they could find and examine data related to Vermont forest condition was the most significant aspect of the Dashboard. Notably, no one said that the scores were an important feature of the Dashboard, but several people did say that including the methods was important and added credibility to the scores and the trends. Many people liked several aspects of the presentation and functionality of the Dashboard. For example, they liked the provision of links to other resources, the concise web pages with "quick and easy" information for each indicator, the "beautiful presentation", and the straightforward writing that can be easily interpreted and used by a variety of people, such as legislators, who may not have a forestry or ecology background. Most people we interviewed said that the amount of information provided in the Dashboard was appropriate for their uses and that they appreciated that it was up-to-date and well-maintained. In general, most people found the visual presentation of the Dashboard to be approachable and that, while not all agreed on the exact categories or

datasets currently included, agreed that breaking up forest conditions into categories was helpful because it tells a more complete picture of the many values of forests.

DATA NEEDS

The three most common comments we received from interviewees about data needed from the Vermont Forest Indicators Dashboard were data on socioeconomic factors such as forest-sector employment and spatially-explicit data.

Breaking down these general themes, the feedback included suggestions to add or modify metrics included in the Dashboard. Comments on data needs regarding additional forest fragmentation information included forest parcelization and connectivity, as well as a metric to assess if the spatial pattern of forest blocks is functional for wildlife connectivity and climate resilience. The comments on including additional socioeconomic data on the Dashboard tended to come from those working directly with policy and planning. Having data on how forests impact human lives over time -- for example through jobs, forest products, and recreation-- was identified by several people as being more directly related to policy compared to ecological data. One interviewee suggested that socioeconomic data could be its own indicator category on the Dashboard. Finally, the need for spatially-relevant forestry data was especially true for those working at the local-level, such as planners and people working at non-profit organizations. People mentioned several specific types of spatial data they would want: critical resource and habitat areas, locations of possible development that would avoid impacting forest connectivity, timber harvests, prime locations for carbon sequestration, improving carbon stocks through silviculture, or implementing carbon markets, and areas that could be managed for certain forest characteristics and services. Municipalities especially voiced a need for local data, but one person mentioned the utility of regional-level data within Vermont and another suggested providing local data just where it was available so that the Dashboard would have both state-wide, as well as local data for certain variables.

Several people mentioned the need to include more information on climate change as a potential stress agent. One interviewee made a point that climate change stressor data would not need to be spatially relevant, due to its broad nature, but that localized data on snow cover, forest composition and age class, and timber harvests would be helpful for creating forest management plans and grant proposals. Another interviewee said that they would like local data on the impacts of climate change on forests, including where invasive species are expected to arrive, and where certain species of trees are expected to disappear.

There were other data needs that were mentioned with less frequency than the three broad categories discussed above. These include data on forest ages, representative physical landscapes, and forest species composition. One interviewee called this "data on basic forest demographics." Also mentioned were several metrics utilized for more organization- or issue-specific applications, including a need for data on bird habitat, forest road and transportation networks, riparian zone conditions, degree of compliance with AMPs (acceptable management practices), public access to forests, flood resilience and other water related services such as water quality and surface water protection, and forest biomass harvesting. Of this list, data on water quality services provided by forests was the most frequently mentioned followed by forest biomass harvesting data. Several of those who mentioned forest biomass harvesting also noted a need for data on the implications of biomass use on forests as well as data on the emissions that come from advanced wood heating technology versus older wood heating technology, pellet wood heating, district-wide wood heating,

and the overall amount of heat that comes from wood in Vermont. This kind of data on forest biomass and wood heating may be beyond the scope of the Vermont Forest Indicators Dashboard, but it is worth noting that several people would like this kind of data and similarly, data on timber harvesting impacts. If such data is available, links to it from the Dashboard may be worthwhile.

One interviewee emphasized that social data on forest ownership demographics would be helpful. Data about the age of forest owners, parcel size by owner, and other social science data would not necessarily contribute to the overall score on forest conditions, the interviewee said, but these demographic changes in forest ownership is a driver of forest conditions and forest policy decisions, and it also tells a more holistic story of Vermont forests.

Finally, those working with Regional Planning Commissions (RPCs) mentioned that RPCs have internal, localized data that could be included in the Dashboard. Examples of these data include undeveloped river corridors, contiguous riparian habitat, forest stewardship land, and wildlife corridors.

The key limitation to adding datasets to the current dashboard include the availability, longevity and quality of data for input. Current metrics included were selected to meet several minimum requirements to ensure that a baseline, or ideal condition for that metric could be identified; that data was collected on a minimum yearly basis to allow for the examination of trends over time, and that data documentation and quality met rigorous scientific standards. Several of the additional metrics suggested by stakeholders may meet those requirements, but others are not appropriate for inclusion.

IMPROVEMENTS IN INTERPRETABILITY OF DATA

While interviewees were browsing the dashboard during the interview, a few of them noted some problems that they had with the data currently in the Dashboard. This typically occurred when the current condition or long-term trend in the data did not match the "gut" feeling of the stakeholder based on their personal experience. Three people noticed that the data for recreation rates said the trend was going down, while their own personal knowledge of recreation would suggest otherwise. One person with an ecology background noticed that "contagion index" is the unit of measurement in the forest connectivity data but, despite their background, was not familiar with this unit and so therefore made the data less understandable. One person took issue with the forest cover score of 1.9 out of 5. Unlike most other interviewees, this person felt that forest cover in Vermont, at around 75%, is a success story to be shared and that this score did not reflect that. Finally, one interviewee felt that the data in the Dashboard as a whole reflected a bias of timber being the primary forest service, as opposed to water quality and flood control services.

NEEDS FOR DATA-CLARIFYING INFORMATION

While not related to suggestions about current or future data in the Dashboard, there were several suggestions made about improving the presentation of the data or regarding clarifying information to be included alongside the data. These generally fell under the category of providing additional text for context around the patterns witnessed in the data. One suggestion that came up many times was to provide a clear description of the graph for each indicator, especially if the graph looks like it is going in one direction but the trend is stated as something different. More specifics about this suggestion will be discussed in the following section on trends. Secondly, two people suggested that the Dashboard make note of what percentage of the data used is derived from conserved lands. This could be helpful for determining which indicators are

protected and which are not, thus also illustrating how vulnerable some of the indicators may or may not be. Third, several interviewees wished the Dashboard had more information alongside the score that discussed "why?" and "now what?" For example, why is the bird diversity trend going down? What can be done to ensure that carbon storage continues to go up? What do the scores and the trends mean for policy and planning? What can or should be done about them? Similarly, one person said that they would like it if the Dashboard could tell them "if X policy decision was made, it would have Y impact on Z indicator." In other words, both municipal and state-level interviewees want the Dashboard to tell them the policy implications of the indicator scores and trends. In other words, they would like information on how good forest management and policy promotes healthy forests.

Other suggestions, made less frequently, requested clarifying information to accompany the data visualizations, for example explicitly stating how a 'forest' is defined on the Dashboard (e.g., are urban forests defined as 'forests'?), making it clearer that the scores and trends in the Dashboard are state-wide estimates as opposed to site specific, providing information about when updates have occurred and will occur, and having a link to a technical paper about how the technical committee made decisions such as the weighting of the indicators. This last suggestion was made with an emphasis on the fact that users will need to have confidence that the data in the Dashboard is accurate and that the scores are reasonable.

Requests were also made for additional data visualization to facilitate rapid communication for specific aggregate subsets of data for decision makers to utilize. One suggestion was to have long-term trend charts for each of the four categories of data on the Dashboard, as well as for the overall score, as such visualizations of trends in categories such as forest services would be very useful to display in a PowerPoint presentation. Finally, one interviewee suggested that the Dashboard could provide regions with forest condition targets in the same way that Vermont's Comprehensive Energy Plan has state-wide targets that are broken down into regional targets.

IMPROVEMENTS FOR REPRESENTING LONG-TERM TREND DATA

The majority of interviewees noted some confusion around the direction of trends and interpretation of those trends. For example, sometimes an upward trend indicated improvements while other times an upward trend indicated decline. This confusion was compounded by the juxtaposition of trend data with red (declining), yellow (stable) and green (improving) indicator symbols. A few of these interviewees indicated awareness that a target for a particular indicator may be up or down and so therefore the direction of the trend does not necessarily mean good or bad. Everyone, however, despite this awareness, expressed confusion on this issue. A brief reading of the paragraph underneath the chart did not make things clearer for the interviewees and neither did clicking on the score or the trend color to read the "interpreting the score" pop-up. In one interviewee's words, reading these text sections was very dense, but the chart itself was very simplistic. Another said, "What is used to determine a trend? Is there some statistical analysis going on behind the scenes? I don't see anything on the chart about what's being used. For instance, mean patch size looks like it's going down but the trend says yellow. Is that because of error bars? Can you look into the data and uncover why?" Suggested improvements include altering axis or metric standardization to create a more intuitive graphic of trends over time.

IMPROVEMENTS FOR REPRESENTING TARGETS

Some of the confusion around the trend charts is related to confusion over the target conditions. Most interviewees asked some variation of, "what does a five mean?" They found the score difficult to interpret and, as noted above, reading the "interpreting the score" pop-up did not clear things up. On top of that, all interviewees needed to be instructed on how to find this pop-up. Almost everyone wanted information on the target (how it was calculated and by who?) to be clearer and more easily found.

Certain examples of this kept emerging, especially for the timber harvest dataset. Many interviewees saw the trend going down and wanted to know if that was bad or good. What is the target for timber harvesting and why? What does a 3.5 mean since there are no units? The "interpreting the score" pop-up says that the target is "the maximum plus 10% of range" but no one knew what that meant. Another example includes the growing season length. What is the target and what does it mean that the trend is going down when the chart line is going up? Does that mean that the growing season is increasing but that that is bad? Does the green trend under drought mean that there is less drought or more? Why does "damage by pests" get a five out of five considering emerald ash bore in the state? Finally, the methods section for mean patch size says that the target is to maintain the long-term mean. One interviewee said, "That means that of course we are not going to have a trend, because the target is going to change as the mean changes. What's going to score as a five is just going to get lower and lower over time and that's not how I think about it. I think about it as we want to maintain or grow our forest patch sizes, even though that's probably not possible."

SUGGESTIONS FOR THE STRUCTURE OF THE DASHBOARD

The most commonly mentioned suggestion for improving the structure of the Dashboard was to make it more clear which indicators have low scores or are trending away from the target. As one interviewee said, "it would be great to clearly show 'here are the things we are doing really well at' and 'here are things that are really alarming.'" The way the Dashboard is structured now, several interviewees noted, one has to go through multiple clicks to get to the indicator scores and find out what may not be doing well within the aggregate score. One has to "drill down deep", as one interviewee stated, to find information on forest patch size. The score and the trend on the main page does not convey the story of the any single metric that may be of interest.

Less frequently stated suggestions include improvements to the way the forest condition indicators are grouped and organized. To quote one interviewee: "It's confusing because in services, there's economic services and there's things like carbon storage, which is really important but is really different than timber harvest; the mixing and matching of pieces gets confusing. If I want to make a policy argument about how important forest connectivity is and how we are losing forest connectivity and I wanted to use the forest patch size data here, I don't think I could hammer home that message if the number for forest patch size is also wrapped up with other numbers for things like softwood regeneration. Having datasets that are so different (different metrics, different scale) within one bucket (i.e., structure) makes that one number is not as meaningful for policy." Instead of mixing so many ways of looking at forest condition, this person suggested that the Dashboard should tease out exactly what indicates a healthy forest or, more simply, what people want to get out of the forest, such as economic benefits, and separate out and focus on those uses. Another suggestion for the structure of the Dashboard was to use the same targets and metrics that are in the Vermont Conservation Design. Use of these targets for metrics such as forest types, forest ages, or

forested wetlands would more directly allow the Dashboard to be used to measure progress toward state-defined goals.

A final suggestion for the structure of the Dashboard hinges on the expressed need for localized data. As noted in the section on data needs, one interviewee suggested that if there are limitations on what data is available at the local level, the Dashboard could break apart where there is localized data and where there is not so that there is two tiers of data—in other words, have the local data available where it exists. "Often we are communicating with legislatures from a particular district so our conversations are geographically focused," said one representative from a state office. This person did not suggest having local data if that was not possible, but instead said that "a faster, easier, more transparent method for determining the geographic scope of the data that is presented would help. This tool could have a map with areas that show high or low confidence in the data value that comes out, or areas of high or low indices spread geographically. So looking at a map that shows, for example, where timber harvests are highest or lowest."

SUGGESTIONS FOR FUNCTIONAL ASPECTS OF THE DASHBOARD

As was mentioned previously, the "how to interpret the score" pop-up window was not easy to find for many interviewees. There were other suggestions related to functionality. Many people said they would not have been able to find the buttons that would allow them to make a PDF or JPEG of the charts if they had not been shown to them. Others said they would not have known to click the "i" button at the top of the Dashboard to find the methods and background information. While working within the Dashboard, a few interviewees noticed that some links did not work and one interviewee noticed that the function to make a PDF or a JPEG of the charts did not work. It was noted that FPR websites are new so those links may need to be redone.

More substantial functionality suggestions including having the ability to print out a one-page summary for each indicator, as opposed to just the trend charts, as well as a one-page overview for the entire Dashboard. Another interviewee said that the colored circle next to the score is not something immediately understandable when the Dashboard is first opened-up. In order to understand what this symbol means, one has to click on it and it was suggested that understanding the color be something described right on the homepage. Finally, one interviewee felt it would be useful to be able to combine indicators together and compare them—for example, integrity versus species viability.

Uses for the Vermont Forest Indicators Dashboard

Interviewees felt the Vermont Forest Indicators Dashboard would be useful to help them, or help them help others, in planning for the future of Vermont forests. The sections below constitute a range of general uses envisioned by interviewees for this product, with specific ideas or details described in more detail. Overall, the data provided in the Dashboard tells a compelling story about the complexity of forest conditions and how those conditions are impacted, and will continue to be impacted, by the human history in Vermont.

ASSESSING PROGRESS ON STATE-WIDE GOALS

Vermont Fish and Wildlife, as well as several of their partners, have created the Vermont Conservation Design—a map of forest blocks that are of the highest priority for conservation efforts. VFW and their partners are presenting the VCD to audiences such as land trusts, foresters, private land owners, and policy makers as the state of Vermont's vision for where conservation of forests is most important. These forest blocks are identified in the VCD as areas that represent a variety of physical forest landscapes, such as diverse

forest structures to forest ages, and that also can be pieced together to provide for ideal forest connectivity patterns.

VFW does not have indicators to help them measure how well the state is doing at achieving the goals of the VCD. The department knows how much land is in conservation and how much is in the current use program, but knowing this does not allow them to assess how well they are achieving their vision of maintaining a diversity of representative forest landscapes. The Vermont Forest Indicators Dashboard could allow them to do this based on metrics in common with the VCD vision metrics.

Similarly, interviewees who work on forest conservation efforts outside of VFW expressed how the Dashboard could be used to help them understand the quality of forests in conservation—from indicators of water quality to wildlife habitat to forest connectivity. The Dashboard shows where forest conservation efforts could do better at achieving these conservation goals. This is useful for forest land in conservation and in the current use program, but also for land in the National Forest, which also attempts to meet the state's goals for representative age classes, forest composition, and biodiversity. While the Dashboard is not specific to the National Forest, it could help those who work there to understand where it falls in terms of the state trends and so how they can better assist the state in meeting forest conservation goals.

DETERMINING GOALS, PRIORITIES, AREAS FOR ACTION

Just as the Dashboard could be used to determine how well the state is doing at achieving current forest conservation goals, it could also be used to determine new goals and new conservation strategies. As one interviewee said, "It could be a big tool for allocating public funding, for reprioritizing, in a rapidly changing climate, what it is we are trying to achieve through the current use program." Other interviewees also brought up diverse goals other than representative physical landscapes and conservation that the Dashboard could help to developed, such as those related to air and water quality services that forests provide.

As the quote above suggests, creating new state-wide goals is tied with allocating state funding. One interviewee said that the Dashboard could help their organization decide what percentage of their funding should go to particular uses. By knowing the condition of Vermont forest and, more specifically, the benefits that forests provide and the threats to those benefits, the Dashboard would bring insight into decisions around how much of the annual budget should be allocated to address those threats. Having knowledge on what issues need to be prioritized allows for more informed decisions and justification for funding specific conservation projects. Each conservation project may or may not help an effort to reverse a negative trend or increase an indicator that has a poor score. Those that do would rise in priority and urgency for funding.

The Dashboard could also help to determine similar goals but on a local level. Interviewees that work with municipalities or local forests said that the tool could function as a state-wide reference to compare with their specific area of interest, in order to determine "if we are at least as good as or better than the state" and so thus know the appropriate goals for management in that specific locality. This is true for local forests as well as for Vermont's National Forest. Being able to compare local trends to state-wide trends not only allows for informed management goals, but also allows for informed management decisions, such as those related to dealing with extreme weather events, one interviewee said.

Beyond funding priorities and management goals, the Dashboard could help to identify critical or emerging issues and determine advocacy goals for those interviewees that do forest advocacy.

USE WITH THE STATE LEGISLATURE

On some level, almost all of the interviewees do some form of forest issue advocacy and this is especially true of those that are called upon to testify to the Vermont State Legislature. Commissioners and Executive Directors, for example, while not directly forest advocacy positions, are people who are asked about forestry data when they testify and their choice of what data to present tells a story that shapes the priorities of the legislature. Some interviewees said that they would use certain data sets in the Dashboard depending on what policy is being addressed in the legislature, while others said that the data sets themselves would determine what policy they would advocate for. An example of the former is in the 2019 legislative session, in which the legislator is doing a total examination of Act 250, Vermont's land use development law. Specifically, the legislature is looking to address and improve the criteria to address forest fragmentation. Several interviewees said they could imagine using data and charts in the Dashboard to prepare for testimony in which they would present the trends about loss of forest cover and the rate at which it is happening. Having this data in PowerPoint presentations during testimony would be powerful because, as one interviewee said, "Some people need to be convinced, not just that forest loss is happening, but that the loss of forests is important. This tool could do both." In other words, the Dashboard tells a story about forest services *and* how they are being lost—a powerful combination.

Commissioners and Executive Directors are called upon to by senate committees to give testimony about the state of the forest. "They ask me to give an overview of forests: ages, conditions, how much land is in forests, growth and decline, what are the threats, is it healthy, general trends and changes over time…and I go way too fast! This tool would help with that overview." PowerPoint slides and print-outs are useful in testimony, but it would also be possible to, as one interviewee stated, "take [the Dashboard] for a spin" in a committee meeting. This is an example of state legislatures discussing forestry issues with experts in a less formal setting than prepared testimonies and, together, identify policy priorities. Using the Dashboard in that regard, the interviewee said, "would result in a lot of probing questions and it would result in [the legislature] making better decisions about things like invasive pests." Similarly informal, many state legislatures will approach experts in the hallway of the State House and ask questions of interest to them. These more curious state legislatures may want to use the Dashboard on their own and, in these instances, the interviewees said they could direct legislatures to the Dashboard as, in one person's words, "they won't read scientific papers."

Some interviewees were less broad in how the Dashboard could be used in interactions with the legislature and noted specific data that would be of interest. Many interviewees agreed that legislatures would be particularly interested in "the part about stressors and trends there that are going in the wrong direction." One interviewee said that the data on maple syrup may be of interest to the legislature and another said that some legislatures are constantly searching for information on climate change's impact on Vermont. Whatever specific data legislatures may want, one interviewee felt that having one location with credible, objective, science-based data where the facts are presented the same to everyone is extremely helpful for using with the legislature, who are often confronted by groups of people who disagree on forest policy. Having objective data can demonstrate to legislatures how policies, or a lack of policies, can have an impact on the services that forests provide. This, however, may be at odds with the suggestion that the Dashboard provide more detailed explanations on the policy implications of the data and trends presented.

FOREST MANAGEMENT USES

It was previously mentioned that the Dashboard could help develop conservation strategies and priorities. Similarly, the Dashboard could help forest managers decide, or confirm, what needs to be focused on in forest management. This includes timber harvest treatments to meet natural variability goals, decisions regarding recreation, such as if and where to create snow mobile trails, and accounting for increased forest stressors when making management decisions such as where to plant certain species. Stressors, in particular, was mentioned as useful data for forest management and management plans. Data on forest stressors could help forest managers create more resilient forests that may be more adaptive to climate change, and it could also help anyone who might want to comment on the management of public forests.

It was also noted that the National Forest Service needs to ascertain the effects of their decisions on non-national forests lands and that the Dashboard could be used for this purpose. The National Forest Service is required to submit cumulative effects disclosures on non-federal lands for decisions that are being made on federal lands. This Dashboard could be useful for this work done by NFS employees in Vermont.

PROVIDING DATA TO CONSTITUENTS, CLIENTS, OR MEMBERS

Several interviewees talked about using the Dashboard when conducting outreach with the public or with their members or clients. For example, a county forester could talk about the data when talking to a private land owner, that the tool could be used when providing clients with technical assistance or providing members with information in a newsletter, the data could be presented to board members or partners and local communities working on specific forestry projects, and the data could be used in public presentations that many government officials conduct. Government organizations are interested in explaining the value of the work that they do to the public, as well as explain specific management and conservation actions they take and this Dashboard, especially the trend charts, could assist with that kind of conservation education—from formal presentations to a link to the Dashboard on the Forests, Parks, and Recreation website. All of the interviewees who work with private landowners said that they would use this tool for educating the landowners that they work with and one interviewee, who was once an environmental lawyer, said it would have been useful for them to use with their clients.

MUNICIPAL USES

Four interviewees work directly with municipalities and mentioned ways that this Dashboard could be useful for forest-related policies at the local level. For example, town plans include a chapter on the status of local forests and will often include statistics on forests state-wide in order to support their conservation efforts. These town plans also discuss forest blocks and forest continuity. Regional Planning Commissions, as well as some non-profits, help to provide much of this background data for the town plans as well as provide technical assistance to municipalities on ways that they can improve their land use approaches through forest land management and conservation. The Dashboard would be very useful for providing the state-wide data that is included in these town plans as well as demonstrating to the town volunteers who write these plans what is important for forest management efforts. Interviewees said that many towns in Vermont want to have a meaningful contribution to reversing negative state-wide trends, but many of the volunteers, who often do not have a forestry or ecology background, need to be shown that local forests have value beyond just aesthetics. Thus, this tool could help those who provide towns with technical assistance to more effectively communicate with volunteers about the services that forests provide, as well as concerns about

negative trends in our forests, such as increasing land parcelization, which conservation-based regulations can help to address—not just for meeting state-wide goals, but also for meeting local, town-specific goals.

It is also worth noting that one interviewee mentioned the creation of sighting maps that indicate which local areas are suitable, or not, for solar, wind, and biomass energy production. Combining local maps with the knowledge on negative trends in the Dashboard could be used to inform this effort so that renewable energy production is not done in such a way that worsens the conditions of Vermont forests.

GRANTS AND FUNDING

The final category that many interviewees mentioned for how this tool could be useful for them pertains to applying for grants and project funding. Interviewees often mentioned specific grants they were interested in applying for, but they also mentioned a broader need for assistance with climate change stressors. For those who mentioned the need for spatially relevant data, a few noted that the spatial limitation of the dashboard could actually be used to make the case for monitoring funding and for acquiring local or regional level data.

INDICATOR DASHBOARD MODIFICATIONS

Completed Improvements

Based on the findings from these interviews, changes to the Dashboard have already begun. Changes on the user interface primarily focus on suggested improvements for data discovery, trend data and the addition of clarifying information described above. These changes have been completed and are being reviewed by staff for roll-out to production. For example, many interviewees found the indicator weighting percentages within the four forest condition categories confusing. For each of the indicators, we replaced the weighting percentages with the current-year score and long-term trend color of that indicator. This change eliminates some of the clicking and "deep digging" that users have to do to find this information for each indicator. As a result, the scores and long-term trends for all of the indicators within a category can be more easily compared. We retained information on weighting percentage information in the category overview pages. To further improve the user interface of the categories, we also added a text box on each category page titled, "How are we doing?" which contains information to help the user better understand the category scores over time.

On each indicator page, the annual scores are now visible in a chart, along with the annual trends in the data itself. This will allow a user to compare the data to the scores, which are based on indicator-specific targets or ideal values. We hope that this change will help clarify some of the confusion we heard from interviewees about the chart trends and scores. Users can now click buttons labeled "Graph Scores" and "Graph Data" that allow them to toggle between the score chart and the data chart. Also added to each indicator page is a "Methods" button that pulls from the database. It is similar to what is currently shown in the general tool overview popup, and includes text that makes it clear that the user can click the score or the trend, to get more details on each. Once in this popup, there is now text that explains the score range and what a score of 1 or 5 means. Finally, on each indictor page, there is now a "Last Modified" button that, when clicked, pops up a modal with the version summary information and a link to switch to the "About Modal Versions" tab.

Another change that will help users understand the relationship between the trend and the score is that the trend is no longer displayed solely in colors. Whereas it may not have been clear if a red, green, or yellow

trend was bad or good, now trends will be displayed as happy, medium, or sad faces. This will also help color blind users more easily understand the trend direction.

Suggestions for structural improvements have also been implemented. For example, the user interface on the overall score main page has been modified based on stakeholder feedback. The "i" button in the banner has been changed to an "about" button. The site header has become smaller and the "Overall Score" has been made bigger. The circles and the numbers on the main page has been labeled "Current Score" and "Long-term Trend." Finally, a slide out menu has been created that lists the component indicators with links to the indicator pages.

Ongoing Improvements

There are three big changes based on these findings that are currently underway and will be added in the near future. The first is custom text that will be added in the trend interpretation for each indicator. This custom text will be derived from expert interpretation on the data and trends. An example might read "Growing season length has been deviating from the long-term average more and more each year average. While some species may benefit from this increase, other species will be negatively impacted because the growing season length that the forest has been accustomed to is changing quickly" under "Long-term Trend" for Growing Season Length. Information about this custom text would also be included in the popup that is displayed when users enter the Dashboard site. A second change that is currently being worked on is providing users with downloadable "one pagers" for each indicator, category, and overall. These pages will include a simple summary of what the indictor or category is, how it is quantified, what the current score is, what the trend is, and what the score and trend and score means as interpreted from experts. Finally, a new page will be added to the Dashboard to give users a picture of change over time of the overall score and each component category score, as well as short narrative interpretations of the latest notable trends or changes, complementing the current-year snapshots.

One request that was often noted in interviews was the ability to drill down to data summaries at geographies below the state level, such as regional planning commission boundaries or town boundaries. Due to the varied scale of the data, this is possible for some indicators and not others, and while FEMC staff have developed some ideas on how this could be implemented, a change to accommodate this request is not currently planned at this time.

Once these changes are made, and as a result of the connections made with interviewees who work with state legislatures, the Vermont Forest Indicators Dashboard will be presented to the Vermont Senate and House of Representatives at the beginning of the 2020 legislative session. The result of this presentation will be policy-makers with awareness on their access to data and information to support their decision-making regarding Vermont's forests.

CONCLUSION

The engagement with stakeholders described in this report has provided us helpful feedback for improvements to the Vermont Forest Indicators Dashboard, and already resulted in an improved tool. Additional improvements stemming from the interviews are ongoing. The interviews have also resulted in increased awareness among local and state forestry policy advocates on the data contents of the Dashboard

and its utility for their work. Due to these one-on-one meetings where interviewees deliberately examined the Dashboard and were asked to describe how they might use it, nuanced suggestions emerged that not only guide improvements to the Dashboard, but also exposed natural resource advocates to uses of the Dashboard that they might not otherwise have considered. The results include an improved Vermont Forest Indicators Dashboard with features meeting the specific needs of policy makers and natural resource advocates, as well as stakeholders who are more aware of the resources available to them to support their work to improve the conditions of Vermont forests.

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Pontius, J, J. Duncan and A. Kosiba. Vermont Forest Indicators Dashboard: combining dozens of key datasets into a snapshot of the overall status of Vermont's forests [poster]. In Kosiba A., J. Truong, S. Rotella, J. Duncan, and J. Pontius (Eds.) 2019. Forests and Climate Change: Managing impacts and planning for the future. Proceedings of the December 14, 2018 Forest Ecosystem Monitoring Cooperative Conference: Burlington, VT, Forest Ecosystem Monitoring Cooperative. https://doi.org/10.18125/xJ29uE. Available online at https://www.uvm.edu/femc/annualMeeting/2018/proceedings.

APPENDIX 1: INTERVIEW QUESTIONS

1. After your introduction to this tool, and an overview of its capabilities, what specific information about forest ecosystem condition would you like to get out of this tool?

   a. Is this information currently in the tool?

   b. Is it easy to take this information from the tool and use it for your own needs such as reports or presentations?

   c. Are there other ways you would like this information delivered (textual, graphical, summarized, detailed) beyond the way that it is delivered now in the tool?

2. Do you find the tool to be easy to navigate and understand or, conversely, did you find any part of it unclear or confusing?

   a. Follow up: If any parts were unclear, please elaborate on what they are and why they are confusing.

3. This tool provides quantitative scoring of forest condition. In what situations is this detailed quantitative score useful to your purposes?

4. What are some applications, if any, where a more qualitative statement about forest condition would be useful for your purposes?

5. Was the amount of information provided in the tool about right for your purposes?

   a. If too much information, how would you like to see information aggregated or summarized?
   b. If too little information, what would you like more information on?

6. Are there any current or future legislative, advocacy, management or education activities that this tool could be used to inform? Or for explaining policy decisions to others?

7. Can you provide a specific example of a time in the past when this tool could have been useful for you?

8. What changes could be made to the tool to make it useful for legislative, advocacy, management or education activities? Or for explaining policy decisions to others?

9. Do you have any additional suggestions for how this tool could be more useful to you and your organization?