

Supplementary information

Taking fire science and practice to the next level: report from the PAGES Global Paleofire Working Group workshop 2017 in Montreal, Canada – *Paleofire knowledge for current and future ecosystem management*

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Questionnaires (created by workshop organizers) on the basis of which the conclusions of the workshops were drawn.

Questionnaire 1:

Do you communicate often with Academics (university-based researchers) and from which scientific discipline?

I usually answer that question but telling people that it is a small world and no difficult to speak with people. The majority of the academic researchers I am in touch with are at the University of Saskatchewan in Saskatoon. I speak regularly with Yuguang Bai and Eric Lamb from the Plant Science department of the Agriculture College. They both focus on grassland research. Eric is the PI for the research project at our bison ranch. Yuguang was my supervisor during my M.Sc. on grasslands and greenhouse gases and the current Plant Science Department Head.

My supervisor has recently introduced me to two researchers at the College of Agriculture at the U of S. Candice Pete is head of an aboriginal agriculture and land management program that is relatively new. She is interested in an educational outreach program we have been sponsoring that aims to teach aboriginal children about species at risk in Saskatchewan. She sits on the NCC-SK board.

We have limited contact with the First Nations University of Canada (campuses in Saskatoon, Regina, and Prince Albert).

Do you use scientific evidence (studies and/or data) for defining management policies or targets in your area? If yes, which kind of data do you use?

We plan all of our land management by balancing the best available science and what management practices we can realistically apply based on our internal capacity and the appetite of the community of land owners we are neighbours with and who we depend on to achieve many of our conservation goals. Prescribed fire is an excellent example. We use the relevant literature on fires in the prairie ecosystem to set goals for the frequency and intensity of fire on our properties, but in reality, we are reluctant to implement a burn program without the enthusiastic participation/backing from the ranchers that lease our land for grazing. So, data is based on past research within the prairie ecosystem (Dale Gross, who has begun his PhD looking at burning at our bison ranch, wrote his thesis on the impacts of burning on the plant community of a fescue prairie. His thesis might provide some useful background on research already conducted in the province.)

Do you order scientific studies on your ecosystem of interest? What kind of studies?

What are the main challenges when integrating scientific knowledge into effective management plans for you? (For example: relevant spatial or temporal scale, human resources and understanding? Accessibility of science papers and data)

Really, I think the biggest challenge to integrating scientific knowledge into effective management is the cost of implementing any program that we're not already doing. Not that we don't know what needs to be done or how to accomplish our conservation goals, but that doing so will be expensive to us (man power and equipment to burn safely) and to the people that graze our land (many of plans require greater livestock density and shorter periods of grazing to better emulate the processes the ecosystems evolved under). The second biggest challenge is probably an actual or perceived push back from the community. Fire again – especially after a very dry summer with several large, high profile prairie fires, it will be very difficult for me to implement our prescribed burns for research purposes.

Have you used that knowledge for a better understanding of the ecosystem under your responsibility? And for defining management targets?

Do you believe that long-term knowledge of the fire regime in your area could be useful for defining ecosystem management strategies?

Yes, definitely. I think it will be useful to know how fire frequency and intensity changed with changes in climatic conditions. That will help us better understand how important fire is to the ecosystem.

What kind of data about fire regime knowledge should be supplemented with? (vegetation history, climate data, human demography, land use, etc.)

If there was a way of understand what the grazing pressure was during the different levels of fire regime, that would be great. I believe that grazing, climate, and humans are big drivers of the fire regime.

Which kind of data presentation will be best useful to you? Database with raw data, graphics, scientific articles, maps, transformed and calibrated data (which units?), etc.

I map showing gradations of fire frequency would be useful. I would like to know how large fires were. I'd be open to suggestions.

What level of engagement would be useful between academic fire researchers and your policy analysts and management plan development teams?

I'm really not sure. We use a model of planning that has us seeking out experts in the fields we are working to answer the questions that arise as we develop our management plans. In the past we've asked for review of plans or asked very specific questions on data we are using. I am open to suggestions.

Would you be interested in promoting paleoecological and paleofire studies, in your geographical area of interest? Would you be reassured to work/deal with an international group of paleofire specialists?

I think that as our research project progress it would be very interesting to host fire specialists and hear what they have to say. I think it would be useful to use available scientific knowledge that improves our management.

Questionnaire 2:

Do you communicate often with Academics (university-based researchers) and from which scientific discipline?

Not very often, the communication is about soil fertilizer, land suitability and quality of the (Acacia) plantation. They are from the Faculty of Agriculture.

Do you use scientific evidence (studies and/or data) for defining management policies or targets in your area? If yes, which kind of data do you use?

Yes, we use scientific evidence for defining management policies or targets in our area, data we use are water fluctuation of sea water (tidal) and rainfall for water management.

Do you order scientific studies on your ecosystem of interest? What kind of studies?

Yes, we order scientific studies about soil and plant fertility and water management

What are the main challenges when integrating scientific knowledge into effective management plans for you? (For example: relevant spatial or temporal scale, human resources and understanding? Accessibility of science papers and data)

The main challenge is how to make a project low prize and maximize profit and also make use of existing labor efficiently

Have you used that knowledge for a better understanding of the ecosystem under your responsibility? And for defining management targets?

Yes, we used that knowledge for better understanding of the ecosystem under our responsibility

Do you believe that long-term knowledge of the fire regime in your area could be useful for defining ecosystem management strategies?

Yes we believe it

What kind of data about fire regime knowledge should be supplemented with? (vegetation history, climate data, human demography, land use, etc.)

Rainfall, tidal, example knowledge on burned area from people around the company and tradition of people about fire usage

Which kind of data presentation will be best useful to you? Database with raw data, graphics, scientific articles, maps, transformed and calibrated data (which units?), etc.

Rainfall, tidal, satellite image, land elevation

What level of engagement would be useful between academic fire researchers and your policy analysts and management plan development teams?

The level of engagement would be useful between that about fire, water management, land suitability and crops

Would you be interested in promoting paleoecological and paleofire studies, in your geographical area of interest? Would you be reassured to work/deal with an international group of paleofire specialists?

Yes, we are interested and can work together with paleofire international scientists

Questionnaire 3:

Do you communicate often with Academics (university-based researchers) and from which scientific discipline?

Yes. From Agriculture Faculty, peatland experts

Do you use scientific evidence (studies and/or data) for defining management policies or targets in your area? If yes, which kind of data do you use?

Yes scientific data. Studies on the peatland

Do you order scientific studies on your ecosystem of interest? What kind of studies?

Yes particularly studies on the depth of peat (along transects), vegetation composition and ground water level (water table level)

What are the main challenges when integrating scientific knowledge into effective management plans for you? (For example: relevant spatial or temporal scale, human resources and understanding? Accessibility of science papers and data)

We need practical knowledge

Have you used that knowledge for a better understanding of the ecosystem under your responsibility? And for defining management targets?

Yes

Do you believe that long-term knowledge of the fire regime in your area could be useful for defining ecosystem management strategies?

Yes we are sure

What kind of data about fire regime knowledge should be supplemented with? (vegetation history, climate data, human demography, land use, etc.)

Vegetation and land use as well as human (activities)

Which kind of data presentation will be best useful to you? Database with raw data, graphics, scientific articles, maps, transformed and calibrated data (which units?), etc.

Maps on vegetation data, water table level and peat depth

What level of engagement would be useful between academic fire researchers and your policy analysts and management plan development teams?

We work closely with academic researchers in FGD (Focus Group Discussion) where we discuss and plan

Would you be interested in promoting paleoecological and paleofire studies, in your geographical area of interest? Would you be reassured to work/deal with an international group of paleofire specialists?

Yes we are very interested and want to cooperate in the future

Questionnaire 4:

Do you communicate frequently with Academics (university-based researchers) and from which scientific discipline?

There is little direct communication with academic researchers. However, scientific studies are used at strategic moments in our forestry planning (e. g. in the development of forest certification). It is important to realize that most of our time is spent on our forestry activities including numerous tables of consultation (meetings). In addition, we first have down to earth (technical subjects) concerns with limited interest for scientific people. As much as the scientist lives for his scientific publications, the forester lives to supply his forest industry. However, we are very interested in understanding the reasons justifying our forest management (e. g. selected logging). On this point, the scientific information relative to the subjects of fires, contemporary and Holocene dynamics... is very useful. You also have to understand that since 2013 forest management plan are built by the government and not by the forest companies. We are not the leaders of our management.

Do you use scientific evidence (studies and/or data) for defining management policies or targets in your area? If yes, which kind of data do you use?

As we mentioned before, management policies are developed by the government. However, it is us, the forest companies that we have to complete the forest certification. In the context of this certification, we have to complete the preindustrial portray of our lands. In this context, current fire data and ecological classification are used. Fire data helps us to understand the spatial distribution of logging and forest dynamics. Ecological classification is a valuable aid in defining the type of habitat we manage.

Do you order scientific studies on your ecosystem of interest? What kind of studies?

No, we do not order scientific studies, but we should do it. We have projects to propose, but these are very close to our technical concerns. For example: what should be the retention left in the logging agglomerations ? 10 to 15%, as is currently the case, seems little to us.

There are also questions about interventions in old-growth forests on wetlands. It is thought that intervening in a partial logging will reduce long-term productivity. By creating openings, we think that the paludification will be favored and then the reforestation will be difficult when the regeneration is deficient.

We are also concerned about the management of old forests on mineral soil. One wonders if stands of 70-90 years old could be managed by partial harvesting to create an irregular structure. Logging jack pine in black spruce-jack pine stands would promote black spruce regeneration.

What are the main challenges when integrating scientific knowledge into effective management plans for you? (For example: relevant spatial or temporal scale, human resources and understanding? Accessibility of science papers and data?)

It is not really our responsibility, the forest companies, to integrate scientific knowledge into forest management. The government produce of lot of vulgarized information papers which are available to us. In other words, the integration of scientific data is done upstream our intervention (it precedes us). For example, the sustainable forest management strategy takes into account many scientific studies. In some cases, as in the renewal of our forest certification, scientific studies are useful (e. g. LeGoff). Furthermore, with time good forest ecologists also works for the forest companies and these persons help us to understand the scientific knowledge.

Have you used that knowledge for a better understanding of the ecosystem under your responsibility? And for defining management targets?

Yes, scientific studies are useful to better understand our ecosystems and this is probably their main role. For example, we know that fires in the boreal region are often large and severe and that the residual islands are numerous. This kind of information helps us to understand the spatial distribution of logging.

Do you believe that long-term knowledge of the fire regime in your area could be useful for defining ecosystem management strategies?

Yes. We know relatively well the contemporary natural disturbances.... but we wonder whether these disturbances were so important in the past, in the last millennia. Long term knowledge would give us even more certainty about the current developments based on contemporary fires. The results take a long time to be obtained but they influence the forest management.

What kind of data about fire regime knowledge should be supplemented with? (vegetation history, climate data, human demography, land use, etc.)

Studies on fire regimes should be accompanied by any other studies that enable us to understand the forest dynamics of our ecosystems (ecological types). We are interested in the links between fire regimes and forest dynamics.

Which kind of data presentation will be most useful to you? Database with raw data, graphics, scientific articles, maps, transformed and calibrated data (which units), etc. ?

The data used are forest inventories, ecoforest maps and various popularized management documents. LIDAR data and aerial orthophotographs should be made available to foresters. The scientific articles are difficult to understand for us. We need simplified papers in french.

What level of engagement would be useful between academic fire researchers and your policy analysts and management plan development teams?

The main commitment that we would like to see from researchers is their support for the sustainable forest management that we prioritize, based on numerous scientific studies. The public needs to understand that what foresters do as development is supported by researchers. We need this support to change our image among the population who think too often that the forest is being killed. A film called L'erreur boréale has been the source of many problems (loss of proud by foresters) and of major changes in forest management (Coulombe report). The public is uninformed or badly informed. As regional foresters, we are proud of what we do. The forest world has completely changed.

In addition, links with researchers should be enhanced, but a structure should be put in place, such as a researchers' table or already existing consultation tables with the presence of researchers. These researchers should not only know the fires, but the entire forest ecology and forestry practices related to the regulation that we have to follow.

Would you be interested in promoting paleoecological and paleofire studies, in your geographical area of interest? Would you be reassured to work/deal with an international group of paleofire specialists?

Yes, we would be willing to promote paleoecological studies in order to better understand the evolution of our landscapes. But, before that, it would be necessary for the paleoecologists to demonstrate to us the utility of their researches. Interacting with international groups may not be within our role. The most important for us would be to maintain regular contact with researchers in Quebec.

Questionnaire 5:

Do you communicate often with Academics (university-based researchers) and from which scientific discipline?

Communiquez vous souvent avec des chercheurs ? De quelles disciplines ?

Nous ne communiquons que de manière ponctuelle et occasionnelle avec des chercheurs, cela porte surtout sur les domaines :

- Gestion de crises
- Mathématique et statistique
- Météo
- Hydrologie, comportement des cours d'eau et ruissellement dans le cadre des inondations
- Incendies : comportement des matériaux, agents extincteurs, équipements de protection, comportement des fumées...

Ces rencontres se font surtout au cours de colloques ou retour d'expérience.

Pour autant, nous recevons des étudiants dans le cadre de master 2.

Occasionnellement en France, certains SDIS peuvent collaborer avec des chercheurs, par exemple le SDIS du Gard avec l'école des mines d'Alès.

Do you use scientific evidence (studies and/or data) for defining management policies or targets in your area? If yes, which kind of data do you use?

Utilisez-vous des études ou des données scientifiques pour définir des politiques d'aménagement ? Si oui, quel type de données ?

A l'échelle du service départemental d'incendie et secours (SDIS) nous utilisons peu de manière directe des études scientifiques (notamment issues de recherche fondamentale), en revanche nos services en charge d'élaborer les procédures opérationnelles (direction générale de la sécurité civile et de gestion des crises DGSCGC, école nationale des officiers de sapeurs pompiers ENSOSP, ...), les services en charge de la politique d'aménagement du territoire (direction départementale des territoires et de la mer) fondent plus souvent leurs travaux sur des résultats scientifiques. En ce qui concerne l'aménagement cela repose essentiellement sur les thématiques de risques majeurs :

- Inondations,
- Phénomènes météo,
- Incendies de forêts,
- Mouvement de terrain,
- Mathématique et statistique,
- Sociologie,

Do you order scientific studies on your ecosystem of interest? What kind of studies?

Commandez-vous des études scientifiques sur les zones qui vous intéressent ? Quelles genres d'études ?

Le SDIS ne commande pas directement des études scientifiques, cela relève plus de l'ENSOSP ou DGSCGC.

What are the main challenges when integrating scientific knowledge into effective management plans for you? (For example: relevant spatial or temporal scale, human resources and understanding? Accessibility of science papers and data)

Quels sont les principaux défis pour intégrer les connaissances scientifiques dans des plans de gestion efficaces pour vous? (Par exemple: échelle spatiale ou temporelle pertinente, ressources humaines et compréhension? Accessibilité des documents scientifiques et des données)

Les principaux défis me paraissent être :

- La connaissance mutuelle des deux sphères : sphère scientifique et sécurité civile
- Les conditions d'accès à la recherche scientifique, tout simplement à qui s'adresser et comment valoriser une problématique digne d'intérêt pour une action de recherche scientifique.

Have you used that knowledge for a better understanding of the ecosystem under your responsibility? And for defining management targets?

Avez-vous utilisé cette connaissance pour une meilleure compréhension de l'écosystème sous votre responsabilité? Et pour définir les objectifs de gestion?

Le SDIS de l'Hérault a essentiellement utilisé directement les travaux en termes d'hydrologie pour la gestion et adapter sa réponse au risque d'inondation, et de manière indirecte (au travers des partenaires forestiers) les travaux en termes de risque d'incendie de forêts.

Ces travaux sont essentiellement commandés à des bureaux d'études.

Do you believe that long-term knowledge of the fire regime in your area could be useful for defining ecosystem management strategies?

Croyez-vous que la connaissance à long terme du régime d'incendie dans votre région pourrait être utile pour définir les stratégies de gestion des écosystèmes?

L'action du SDIS porte particulièrement sur la lutte contre les incendies, en ce sens on peut penser que cette action contribue à la gestion des écosystèmes. La gestion des écosystèmes a aussi un impact fort sur le risque d'incendie de végétation.

Il me paraît donc important de connaître le régime des incendies pour :

- Adapter le dispositif de lutte contre les incendies et la stratégie générale de lutte
- Faire évoluer l'aménagement du territoire pour diminuer les aléas et la vulnérabilité des enjeux

What kind of data about fire regime knowledge should be supplemented with? (vegetation history, climate data, human demography, land use, etc.)

Quel type de données sur la connaissance du régime de feu devrait être complétée? (Historique de la végétation, données climatiques, démographie humaine, utilisation du sol, etc.)

Des données sur :

- Le type de végétation et son comportement face au risque d'incendie, la forêt mais pas que ...
- L'évolution du climat et sa conséquence sur la météo et donc sur le risque d'incendie de végétation
- L'évolution démographique, la sociologie et donc l'aménagement du territoire, l'enjeu que cela représente face au risque d'incendie de végétation

Which kind of data presentation will be best useful to you? Database with raw data, graphics, scientific articles, maps, transformed and calibrated data (which units?), etc.

Quel type de présentation de données vous sera le mieux utile? Base de données avec des données brutes, des graphiques, des articles scientifiques, des cartes, des données transformées et étalonnées (quelles unités?), Etc.

La présentation des données doit permettre de la prise de décision pour une application (aménagement, stratégie de prévention, de prévision et de lutte, équipement, ...) en ce sens des graphiques, des articles et de la cartographie paraissent plus adaptés que des données brutes.

What level of engagement would be useful between academic fire researchers and your policy analysts and management plan development teams?

Quel niveau d'engagement serait utile entre les chercheurs universitaires spécialistes du feu et vos analystes politiques et les équipes de développement du plan de gestion?

Le niveau d'engagement doit reposer tout d'abord sur une vision commune de la démarche : définition claire des enjeux de sécurité civile. Ces enjeux portent sur l'anticipation (risque, sociologique et technique), évolution du risque qui peut être liée à l'évolution climatique et son impact sur la végétation et la météo, évolution sociologique portant sur l'aménagement, l'habitat, les bassins de vie et les enjeux qu'ils représentent, sociologique aussi sur les conditions d'engagement des acteurs de la sécurité civile.

Le niveau d'engagement entre les chercheurs et les spécialistes du feu doit être dès l'élaboration de la politique de gestion du risque : objectifs de prévention, de prévision, de lutte et de rétablissement.

Would you be interested in promoting paleoecological and paleofire studies, in your geographical area of interest? Would you be reassured to work/deal with an international group of paleofire specialists?

Souhaitez-vous promouvoir des études paléoécologiques et paléofeu dans votre zone géographique d'intérêt ? Seriez-vous rassuré de travailler / traiter avec un groupe international de spécialistes des paléofeu ?

Les échanges internationaux sont très riches d'enseignements, mais la politique de gestion du risque et donc la stratégie de réponse repose entre autre sur l'évaluation des enjeux. L'évaluation des enjeux est propre à la perception de chaque pays (En ce sens l'aspect sociologique est un repère d'évaluation qui me paraît propre à chaque pays).

Dans le cadre de travaux internationaux, le repère sociologique me paraît important d'être chaque fois rappelé.

Pour répondre mieux il me manque les définitions précises de paléoécologie et paléofeu.

Questionnaire 6:

Do you communicate often with Academics (university-based researchers) and from which scientific discipline?

Yes I do communicate with Academics especially from hydrobiology and ecology discipline.

Do you use scientific evidence (studies and/or data) for defining management policies or targets in your area? If yes, which kind of data do you use?

Yes I use scientific evidence like studies or data when I am forced to prepare methodological design or scope of environmental surveys which are necessary for environmental impact assessment studies. I use mainly methods published by scientist or comparative studies concerning various groups of plants and animals occurring in freshwater and marine ecosystems.

Do you order scientific studies on your ecosystem of interest? What kind of studies?

Currently I do not order scientific studies. I use widely available papers from the different websites or from libraries.

What are the main challenges when integrating scientific knowledge into effective management plans for you? (For example: relevant spatial or temporal scale, human resources and understanding? Accessibility of science papers and data)

In my opinion the main challenge to integrate scientific knowledge into effective management is to find out an easy way to translate the scientific language into practical use of the data. Some discoveries and research results because of their complexity are difficult to use in an easy practical way in an ecological managing.

Have you used that knowledge for a better understanding of the ecosystem under your responsibility? And for defining management targets?

I have used that knowledge for a better understanding of the ecosystem under my responsibility, but in a narrow extent so far.

Do you believe that long-term knowledge of the fire regime in your area could be useful for defining ecosystem management strategies?

In my area of interest long-term knowledge of the fire regime could be useful in the context of understanding the general ecosystem history and ecosystem management. I believe that such knowledge should be more emphasized in the environmental impact assessment issue.

What kind of data about fire regime knowledge should be supplemented with? (vegetation history, climate data, human demography, land use, etc.)

I think that data about the vegetation history and human land use could be very useful in better understanding of past ecosystem changes in the context of urban development.

Which kind of data presentation will be best useful to you? Database with raw data, graphics, scientific articles, maps, transformed and calibrated data (which units?), etc.

Graphics, scientific articles and maps.

What level of engagement would be useful between academic fire researchers and your policy analysts and management plan development teams?

Academic fire researchers could be engaged in my management plan development as a group of specialist consultants cooperating with me and my team in a way of constructive research planning and expert assistance.

Would you be interested in promoting paleoecological and paleofire studies, in your geographical area of interest? Would you be reassured to work/deal with an international group of paleofire specialists?

Yes I do. In my opinion paleoecological and paleofire studies are still poorly incorporated in ecological management policies, so I am open to promote useful paleoecological and paleofire data and studies in my area of interest. In the light of these considerations I would you be reassured to work/deal with an international group of paleofire specialists.

Questionnaire 7:

Do you communicate often with Academics (university-based researchers) and from which scientific discipline?

Yes, often during forest management works and preparation of conservation plans, detailed analyses are required, for example geological expertise. Most often foresters cooperate with Faculty of Forestry, Poznan University of Life Sciences.

Do you use scientific evidence (studies and/or data) for defining management policies or targets in your area? If yes, which kind of data do you use?

"targets and polices" are created based on actual, very detailed data, collected by tax assessors; they are created when forest management plans are developed for each forest district (this procedure takes approx. 2 years). Taken into account are environmental/field conditions (for example habitat, forest stand (age, wealth)), but also any nature protection/conservation restrictions (for example protected areas and their lagging, birds stands, places occupied by protected or precious plants/animals/species). The most important are data covering last 10 years.

Do you order scientific studies on your ecosystem of interest? What kind of studies?

Habitat and phytosociological studies, inventORIZATION of animals and plants, Natura 2000 habitats.

What are the main challenges when integrating scientific knowledge into effective management plans for you? (For example: relevant spatial or temporal scale, human resources and understanding? Accessibility of science papers and data)

Availability of the information and lack of clear methodology of research. Data at relevant spatial and temporal scale.

Have you used that knowledge for a better understanding of the ecosystem under your responsibility? And for defining management targets?

Yes.

Do you believe that long-term knowledge of the fire regime in your area could be useful for defining ecosystem management strategies?

Not really, as most of the fires that we observe (>90%) is of anthropogenic origin (ignition, burning of rubbish in the forest).

What kind of data about fire regime knowledge should be supplemented with? (vegetation history, climate data, human demography, land use, etc.)

No opinion.

Which kind of data presentation will be best useful to you? Database with raw data, graphics, scientific articles, maps, transformed and calibrated data (which units?), etc.

Database with raw data.

What level of engagement would be useful between academic fire researchers and your policy analysts and management plan development teams?

The most important for forest protection against fires is to propose and implement new and effective monitoring and fast fire detection technologies to extinguish the fire.

Would you be interested in promoting paleoecological and paleofire studies, in your geographical area of interest? Would you be reassured to work/deal with an international group of paleofire specialists?

Only as a curiosity or to broaden the knowledge about the landscape.

Questionnaire 8:

Do you communicate often with Academics (university-based researchers) and from which scientific discipline?

Yes. In my role I communicate on a weekly, sometime daily basis with university researchers. AFFES has only modest in-house science capacity (myself and 3 full-time positions dedicated to fire science). We rely on seeking out and building collaborative relationships with university researchers to work with us on high-priority applied science questions to meet our innovation and continuous improvement requirements. Scientific disciplines that we frequently reach out to for assistance are fire behaviour, fire decision support modelling, statistics, analytics, human health, wellness and injury prevention, and technology and equipment design and innovation.

Do you use scientific evidence (studies and/or data) for defining management policies or targets in your area? If yes, which kind of data do you use?

Yes. AFFES and the MNRF are science-based, applying science-based evidence, data, and information to the development and implementation of our policies, as well as to a wide range of operational guidelines and practices. Of course, science-based information forms only a portion of the information and cost/benefit analyses of any policy or operational program implementation. AFFES uses a wide range of scientific data, information, and expert interpretation and advice to formulate its policies and operational practices. It would not be practical for me to list all the applications of science in our fire management program. However, for example, we use long-term weather data to help understand current weather and fire occurrence probabilities. We use long-term fire behaviour data to help us understand and to predict how each fire is most likely to behave (spread rate, direction, intensity, risk), and then to apply the best available resources at the right time to those fire that pose the greatest risk to human life, to private or commercial property values, or to ecosystem values. We use science-based data to help inform how to best prepare our wildland fire fighters to be mentally and physically prepared to respond safely, effectively, and efficiently to each wildland fire they are dispatched to. We use science-based data to maintain and operate a sophisticated fleet of ground and air-based vehicles and fire fighting equipment, taking into account the duty hours and types of use each vehicle and equipment type is subjected to, and the costs/benefits/hazards/risks of when we pull equipment from active duty to carry out inspections and maintenance procedures.

Do you order scientific studies on your ecosystems of interest? What kind of studies?

Yes. AFFES staff and management regularly discuss where our knowledge gaps are most significant, offer the highest probability of improvement in outcomes or cost-savings, or expose our staff and equipment to the highest risk. All of these are examples of where a targeted study has been or will be commissioned to generate and transfer new knowledge into our program. For example, we are working to better understand wildfire behaviour in fuel types that have not been extensively studied in the past, such as boreal jack pine and spruce blowdown areas. We are working to better understand how climate change is affecting all of our Ontario forest ecosystems and the changes to wildfire occurrence and spread rates that might result from those changes. We are working to better understand how our use of water from lakes and rivers to suppress wildfires might interact with invasive alien species, and are working to develop new policies and standard operating procedures to reduce the risk of spread of invasive alien species. We use a variety of studies to meet these knowledge requirements, including literature surveys, long-term data synthesis and meta-analyses, observational studies, and designed experiments.

What are the main challenges when integrating scientific knowledge into effective management plans for you? (For example: relevant spatial or temporal scale, human resources and understanding? Accessibility of science papers and data?)

There are many challenges to generating new knowledge, to transferring it to operational wildfire management policy and practice, and to measuring the impacts of that knowledge and knowing that it helped and how much. Some of the biggest challenges we face are:

The baseline variability of climate and weather, and then the added uncertainty of climate change and its effects on forest vegetation, hydrology, precipitation, relative humidity, wind speed and direction, lightning, etc., and on the frequency of fires and their severity once ignition has occurred.

Quantifying uncertainty and communicating that uncertainty from the science community to the policy and operational fire management specialists in every aspect of our understanding of wildfire causes and driving forces is always difficult. Uncertainty leads to real or perceived risk of not making the right decision at the right time, whether that risk is to deploy more resources at higher cost to prepare for and respond to wildfires, or the opposite.

Some data and knowledge is very difficult to generate, such as predicting lightning occurrence and subsequent fire start probability. This is important because lightning is our leading cause of wildfire in Ontario. Another very challenging area of research is cumulative impacts – e.g., the net result of a long history of forest succession, forest harvesting, and fire suppression and their effects on future fire risk and behaviour. A third example of challenge is the human resources challenge of the time required to develop effective training programs, to incorporate new science into those training materials, and to balance the needs of the operational staff to learn and adapt to new knowledge with the needs of staying fully operational and prepared to use the current tools and techniques to meet program objectives.

Have you used that knowledge for a better understanding of the ecosystem under your responsibility? And for defining management strategies?

Yes. Ontario researched and developed a revised wildfire management strategy in 2016. The development of this revised forest wildland fire management policy included significant input from science and analytics experts, synthesis and application of the roles and values of fire in the forest landscape.

Do you believe that long-term knowledge of the fire regime in your area could be useful for defining ecosystem management strategies?

Yes. In fact, AFFES has used fire recurrence frequency and fire interval to help inform previous and current fire management strategies, including our current appropriate response policy. AFFES is well aware of and incorporates the knowledge of different fire regimes into its fire response and prescribed fire programs, from tolerant hardwood forest types in central Ontario, to savanna and open grassland ecosystems, to boreal and far north peat ecosystem types.

What kind of data about fire regime knowledge should be supplemented with? (vegetation history, climate data, human demography, land use, etc.)

How the most probably climate change scenarios will affect future fire regimes (past fire regimes likely will not be adequate predictors of future fire regimes under significant climate change trends)

How did First Nations' use of intentional fire management influence our observed and assumed 'natural presettlement' fire regime models?

How will climate change affect forest and other ecosystem succession, long-term hydrology, permafrost, etc., which all have significant influence on the fuel types we now manage.

What kind of data presentation will be best (sic?) most useful to you? Database with raw data, graphics, scientific articles, maps, transformed and calibrated data (which units?), etc.

The answer to this question is project and objective specific and cannot be answered with certainty in general terms. Perhaps the best answer is yes, all of the above, but targeted to the specific project objectives and target audience. In general, AFFES uses a range of scientific data, information, expert opinion, statistical and simulation models, decision support tools, maps, graphs, and reports, training media, applied user software tools and programs, etc. to transfer and make knowledge and information available to policy makers, managers, and operational staff.

What level of engagement would be useful between academics fire researchers and your policy analysts and management plan development teams?

Ideally, AFFES prefers to work collaboratively with science specialists to help define a specific problem or gap, to translate those observations in to specific information or tools requirements, to design effective and efficient data collection (data mining, observation, experiment, simulation modelling) based on available sources and available financial and human resources, to design effective knowledge transfer tools and methods, and to design and implement performance measures that will measure the effectiveness and relative costs of applying the new knowledge or tool into policy and operations. Of course, we often must live with less than an ideal solution, but we strive to do the best we can with the time, staff and resources that we have available.

Would you be interested in promoting paleoecological and paleofire studies, in your geographical area of interest? Would you be reassured to work/deal with an international group of paleofire specialists?

My general answer, representing an entire staff of wildfire management policy and operational specialists across Ontario is to say, yes, maybe. With any new engagement between our staff, whether in policy, operations, or science and technology development, our approach would be to focus the majority of our available time and resources to ideas, problems, knowledge gaps, and tools and methods that have already been identified as high priority and high probable value of improving what we do or how we do it. At the moment, I am not aware of any specific high-priority wildland fire policy or operational issues or opportunities that require a paleoecology research solution. However, we are also an organization that believes in and supports innovation and evidence-based change. If a sound case is presented for the need and benefits of a paleoecology study or related project,

including a demonstrated operational benefit to our organization and our stakeholders and clients, then we will be interested in exploring work in that area.

Questionnaire 9:

Our work with research institutions is generally guided by our partnership with SEFARI, the collective of six Scottish Research Institutes working across the spectrum of environment, land, food, agriculture and communities. We also sit on the Ecosystems & Land-use Policy Exchange Group (SG forum for connecting academia with practitioners) and are contributing to the joint JHI and SRC research project looking into governance mechanisms which are or could be used to help conserve and promote biodiversity.

Questionnaire 10:

Do you communicate often with Academics (university-based researchers) and from which scientific discipline?

Yes we communicate very frequently with academics.. A whole range of disciplines ranging from but not limited to fire, botany, zoology, vets, fresh water and river scientists. In SANParks and KNP we have extremely strong ties and collaborations with many academics.

Do you use scientific evidence (studies and/or data) for defining management policies or targets in your area? If yes, which kind of data do you use?

Yes we use scientific evidence to support all our policies. We aim to have all our management policies and management interventions/actions supported or underpinned by good science. For fire we use vegetation data/ spatial and remote sensing data, census data for wildlife management. The type of data used will depend on the management action that needs to take place.

Do you order scientific studies on your ecosystem of interest? What kind of studies?

Not sure what you mean by order.. but we do solicit research from academics that can assist us to manage the Kruger National Park and other SANParks. Kinds of studies range from desktop studies to experimental work to lab analysis. We register approximately 200 research projects a year in SANParks.

What are the main challenges when integrating scientific knowledge into effective management plans for you? (For example: relevant spatial or temporal scale, human resources and understanding? Accessibility of science papers and data)

Our main challenge is getting the science into a useable format for management. Knowledge harvesting and translating the science so that our managers understand the work and the reason for changes. We can have the peer reviewed paper but this does not mean that the science is incorporated into the management of the place.. Another issue is getting management relevant scientific research done. We would like to have our managers direct the research that is being conducted. So not research for the sake of research. But make sure that it is relevant and then it would be much easier to implement.

Have you used that knowledge for a better understanding of the ecosystem under your responsibility? And for defining management targets?

Yes we have, and specifically in the field of fire management in the KNP.. I have attached a few papers that have been instrumental in shaping the KNP fire policy.. which I have also attached. But there have been a wealth of research done on the Long Term fire experimental burn plots in Kruger that have shaped the current KNP fire policy.

Do you believe that long-term knowledge of the fire regime in your area could be useful for defining ecosystem management strategies?

Most definitely. In the Kruger National Park we have maintained a long term fire experiment since 1954 and as mentioned above the research undertaken on these plots have been used to shape the KNP fire policy.

What kind of data about fire regime knowledge should be supplemented with? (vegetation history, climate data, human demography, land use, etc.)

Defining the fire regime in the area.. What are the effects of the various fire regimes on biodiversity.. Essentially what is the pyro-diversity that one would need to implement to support biodiversity.

Which kind of data presentation will be best useful to you? Database with raw data, graphics, scientific articles, maps, transformed and calibrated data (which units?), etc.

This would depend on the target audience that you would want to use the data for. For our manager, maps and graphics (clear and concise) to show. For our researchers that work in the park, the raw data (or partially processed data) that they can then use for further analysis will be good. But as mentioned, it will depend on the audience that is going to use the data.

What level of engagement would be useful between academic fire researchers and your policy analysts and management plan development teams?

It would be useful if the academic researcher directly deal with the management and vice versa. In this way each group will be able to get first hand experience as to how the other works. Researchers will get exposed to the

realities of a fire burning and managers will be able to see what type of information we can get from researchers. But very often this is not possible so a science/management link person is good to have.

Would you be interested in promoting paleoecological and paleofire studies, in your geographical area of interest? Would you be reassured to work/deal with an international group of paleofire specialists?

Yes

Questionnaire 11:

Do you communicate often with Academics (university-based researchers) and from which scientific discipline?

not very often on paleoecology; mostly with ecologist and foresters.

Do you use scientific evidence (studies and/or data) for defining management policies or targets in your area? If yes, which kind of data do you use?

Long-term data on species susceptibility to disturbances (fire, pasture) and climate for forest management planning

Do you order scientific studies on your ecosystem of interest? What kind of studies?

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What are the main challenges when integrating scientific knowledge into effective management plans for you? (For example: relevant spatial or temporal scale, human resources and understanding? Accessibility of science papers and data)

Long-term data on species susceptibility to disturbances (fire, pasture) and climate for forest management planning

Have you used that knowledge for a better understanding of the ecosystem under your responsibility? And for defining management targets?

I have no direct responsibility, only an advising role

Do you believe that long-term knowledge of the fire regime in your area could be useful for defining ecosystem management strategies?

Definitely yes

What kind of data about fire regime knowledge should be supplemented with? (vegetation history, climate data, human demography, land use, etc.)

post-fire vegetation dynamics and related land-use

Which kind of data presentation will be best useful to you? Database with raw data, graphics, scientific articles, maps, transformed and calibrated data (which units?), etc.

scientific and related transfer articles

What level of engagement would be useful between academic fire researchers and your policy analysts and management plan development teams?

Close collaboration

Would you be interested in promoting paleoecological and paleofire studies, in your geographical area of interest? Would you be reassured to work/deal with an international group of paleofire specialists?

yes

Questionnaire 12:

Do you communicate often with Academics (university-based researchers) and from which scientific discipline?

Yes, academics from the forestry or ecology sector.

Do you use scientific evidence (studies and/or data) for defining management policies or targets in your area? If yes, which kind of data do you use?

Yes to some extent, studies regarding forest management or studies about ecological preservation and/or conservation

Do you order scientific studies on your ecosystem of interest? What kind of studies?

-

What are the main challenges when integrating scientific knowledge into effective management plans for you? (For example: relevant spatial or temporal scale, human resources and understanding? Accessibility of science papers and data)

Conservatism, forestry is very conservative when it comes to adapting new knowledge.

Have you used that knowledge for a better understanding of the ecosystem under your responsibility? And for defining management targets?

Yes, to some extent

Do you believe that long-term knowledge of the fire regime in your area could be useful for defining ecosystem management strategies?

Yes in some areas at least, especially since it is getting warmer and the fire-weather is likely to get worse and fire regime is likely to change.

What kind of data about fire regime knowledge should be supplemented with? (vegetation history, climate data, human demography, land use, etc.)

Climate and vegetation history is what I think will be most useful.

Which kind of data presentation will be best useful to you? Database with raw data, graphics, scientific articles, maps, transformed and calibrated data (which units?), etc.

Scientific articles, maps and “popular” written articles which are easy to communicate with stakeholders and landowners.

What level of engagement would be useful between academic fire researchers and your policy analysts and management plan development teams?

I do not know.

Would you be interested in promoting paleoecological and paleofire studies, in your geographical area of interest? Would you be reassured to work/deal with an international group of paleofire specialists?

Yes.

Questionnaire 13:

Do you communicate often with Academics (university-based researchers) and from which scientific discipline?

Sometimes. Biology and Ecology

Do you use scientific evidence (studies and/or data) for defining management policies or targets in your area? If yes, which kind of data do you use?

Yes. Mostly fire history data based on dendrochronology work

Do you order scientific studies on your ecosystem of interest? What kind of studies?

Few times. Data on disturbance and vegetation history. Sometimes for guiding management of protected areas but also for pedagogic reasons to support nature interpretation.

What are the main challenges when integrating scientific knowledge into effective management plans for you? (For example: relevant spatial or temporal scale, human resources and understanding? Accessibility of science papers and data)

Acceptance for reintroduction of past disturbance regimes. Capacity in performing management actions

Have you used that knowledge for a better understanding of the ecosystem under your responsibility? And for defining management targets?

For defining policies and management targets, for learning in organization and for visitors

Do you believe that long-term knowledge of the fire regime in your area could be useful for defining ecosystem management strategies?

Yes. Has been for decades.

What kind of data about fire regime knowledge should be supplemented with? (vegetation history, climate data, human demography, land use, etc.)

Vegetation history, climate, land use, ecology of fire dependent species.

Which kind of data presentation will be best useful to you? Database with raw data, graphics, scientific articles, maps, transformed and calibrated data (which units?), etc.

To support policy work: Systematic reviews. To support management decision at site level according to policy: site specific data on disturbances, land use and vegetation

What level of engagement would be useful between academic fire researchers and your policy analysts and management plan development teams?

To produce scientific reviews on relevant topics – managers should define relevant topics and academics should produce reviews.

Collaboration on site specific data can be helpful between managers and researchers

Would you be interested in promoting paleoecological and paleofire studies, in your geographical area of interest? Would you be reassured to work/deal with an international group of paleofire specialists?

Yes, if it supports our prioritized actions. A broader engagement on more general topics is of less interest.

Questionnaire 14:

Do you communicate often with Academics (university-based researchers) and from which scientific discipline?

About once a year: historians, anthropologist, sociologists, forest ecologists

Do you use scientific evidence (studies and/or data) for defining management policies or targets in your area? If yes, which kind of data do you use?

The scientific data are in use during the preparation of national FSC standard and to estimate the risks. Modern views on maintaining and conservation of biodiversity, data on distributions of rare species, they biological and

ecological requirements, the data on high conservation value forests (HCVF). (The concept of HCVF has been developed and published first in 1999 by Forest Stewardship Council (FSC) together with British consulting company Proforest and HCV Resource Network. The concept become an instrument to detect ecological and social values and they management in the landscapes included into harvesting activities.)

Statistical economical data on population, regional red books.

Do you order scientific studies on your ecosystem of interest? What kind of studies?

The scientific studies were ordered from ecologist and sociologists during preparation the national FSC standard.

What are the main challenges when integrating scientific knowledge into effective management plans for you? (For example: relevant spatial or temporal scale, human resources and understanding? Accessibility of science papers and data)

There is evident lack of ecological data for full and effective detection of HCVF. The data on national forest inventory are not free or easily available or could be missing. National scientific database on rare species of animals, plants, fungi and mushrooms are missing. Local information is distributed between different scientific and research organizations (every institution deal with particular group of parameters or organisms).

All data must be as detail as possible. The data must be open and easily assessable for all interested parties (especially to increase the quality of certification).

The main problem lays in mismatch of principles and criteria of FSC certification and Russian legal system. There are contradictions: for example "indigenous people" defined by FSC broadly than in Russian regulations. To match FSC guidelines and criteria there is a need in recognition of all indigenous people. The information on ethnic composition for every settlement is needed. So far that data are absent or remain in commercial statistical reports.

Have you used that knowledge for a better understanding of the ecosystem under your responsibility? And for defining management targets?

The information is in use for development of future national FSC standards which will contain some elements of ecosystem planning.

Do you believe that long-term knowledge of the fire regime in your area could be useful for defining ecosystem management strategies?

Yes

What kind of data about fire regime knowledge should be supplemented with? (vegetation history, climate data, human demography, land use, etc.)

All possible data: the date of last fire (disturbance), climate data, demographical data including ethnic composition of the population.

Which kind of data presentation will be best useful to you? Database with raw data, graphics, scientific articles, maps, transformed and calibrated data (which units?), etc.

Any kind of. So far there is no data, just information on single events (big fire, dry year etc.).

What level of engagement would be useful between academic fire researchers and your policy analysts and management plan development teams?

Detail studies on the model polygons and following incorporation of that information into national standard. Better understanding of the use of that data in forest management planning needed.

Would you be interested in promoting paleoecological and paleofire studies, in your geographical area of interest? Would you be reassured to work/deal with an international group of paleofire specialists?

Yes, in every possible way.

Questionnaire 15:

Do you communicate often with Academics (university-based researchers) and from which scientific discipline?

All the time. Every year NGO communicate with 20 – 30 experts: biologists, botanists, briologists, pedologists, zoologists, sociologists, forest ecologist. There is a need in economists (to calculate the risks).

Do you use scientific evidence (studies and/or data) for defining management policies or targets in your area? If yes, which kind of data do you use?

Yes.

The data from local surveys, the data on high conservation value forests (HCVF), the information on natural dynamic, forest inventory plans and data, rare species lists, the information on ecology and biology of species, species distribution area, location of species, the size of minimal population together with forest management information. All the results of existing previous investigations as well as published articles, personal communications, red books, regional flora and other information on rare species findings. The data come from previous studies as well as the NGO buys the data and / or investigation from experts.

Do you order scientific studies on your ecosystem of interest? What kind of studies?

About 90 % of work done by invited experts. Comprehensive ecological study conducted by various experts: biologists, botanists, lichenologists, briologists, pedologists, zoologists and forest ecologist. Remote sensing and forest inventory maps processing and preparation.

What are the main challenges when integrating scientific knowledge into effective management plans for you? (For example: relevant spatial or temporal scale, human resources and understanding? Accessibility of science papers and data)

Budget limitations, lack of experts with relevant qualification, able to participate in fieldwork and available during project implementation. Misunderstanding between forest managers and biologists, between practitioners and academic scholars. Mismatch of scientific methodology and results of investigation with practical aims of forest management. Promotion of intensive forest management model as an alternative to existing practice.

Have you used that knowledge for a better understanding of the ecosystem under your responsibility? And for defining management targets?

Yes. That knowledge is the basis for establishing nature protected areas, for guidelines on biodiversity conservation and sustainable forest management (e.g. protecting of nesting area of big birds of prey, habitats of orchids etc).

Do you believe that long-term knowledge of the fire regime in your area could be useful for defining ecosystem management strategies?

I think yes. That knowledge could be taken into account in planning forest management planning. It is important especially for forest management.

What kind of data about fire regime knowledge should be supplemented with? (vegetation history, climate data, human demography, land use, etc.)

Spatial data, maps which can be integrated into plans of companies and into silvicultural plans. Detail and local data which could be applicable for practical use. The studies on small model polygons could be useful for the buffer zone. These studies could be used in the development of ecological frames of buffer zone and for producing recommendations for forestry practice in buffer zones.

Which kind of data presentation will be best useful to you? Database with raw data, graphics, scientific articles, maps, transformed and calibrated data (which units?), etc.

Spatial data (not articles neither opinion nor attitude) which are easily applicable. Maps with notes in easily convertible format. Data on model polygons.

What level of engagement would be useful between academic fire researchers and your policy analysts and management plan development teams?

To get the open data, probably invite academics as experts to develop forest management plans and buffer zone planning. The academic might participate as one of the member of expert team.

Would you be interested in promoting paleoecological and paleofire studies, in your geographical area of interest? Would you be reassured to work/deal with an international group of paleofire specialists?

Research – no, it is not is the focus of the NGO. Cooperation in different forms, help with conducting research in the region in exchange for the access to the data and results of research.