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A pan-Canadian assessment of empirical research on post-disturbance recovery in the Canadian Forest Service

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Abstract

Information about post-disturbance regeneration success and successional dynamics is critical to predict forest ecosystem resistance and resilience to disturbances and climate change. Our objective was to identify and classify post-disturbance empirical research conducted by the Canadian Forest Service (CFS) of Natural Resources Canada and their collaborators to provide guidance on future research needs, improving our understanding of post-disturbance recovery in a Canadian context. To achieve our objective, we collected and classified peer-reviewed and non-published literature produced by the CFS between 1998 and 2020 that concerned post-disturbance ecology. We focused on research addressing natural or anthropogenic disturbances, such as wildfires, pest outbreaks, windthrows, forest management, seismic lines, and those that studied processes related to soil, vegetation, fauna, hydrology, and microbial communities. We found that forest harvesting was the disturbance most studied by CFS between 1998 and 2020, followed by fire. Despite the fact that large, forested areas are affected annually by pests, studies on recovery after pest outbreaks were scarce. Other disturbances, such as mining and seismic lines or other abiotic disturbances were rare in CFS literature. Most studies (70%) examined changes in vegetation related to forest management and fire and they were mainly focussed on post-disturbance tree regeneration success. Post-disturbance changes in understory species diversity were also well-studied. Our results provide a geographic overview of CFS research on post-disturbance recovery in Canada and enable the identification of key knowledge gaps. Notably, research focusing on recovery after natural disturbances was underrepresented in the assessed literature compared to studies centered around harvesting. Long-term research sites, chronosequences that substitute space for time, and studies focused on consecutive disturbances are especially important to maintain and establish sustainable forest management strategies in the face of climate change.

Key words: forest regeneration, forest recovery, sustainable forest management, natural disturbance, long-term research

Introduction

Forest disturbances are becoming more frequent, intense, and widespread due to global change (Sommerfeld et al. 2018; Lindenmayer and Taylor 2020; Collins et al. 2021). These changes in disturbance regimes raise concerns that forests are losing their resilience to future disturbance events (Reyer et al. 2015; Whitman et al. 2019; Albrich et al. 2020). Measures of post-disturbance recovery are commonly used to quantify ecosystem resilience to a disturbance (Ingrisch and Bahn 2018; Willis et al. 2018). After major disturbances—such as wildfire, insect outbreaks, and harvesting—the early stages of recovery can be key determinants of future forest composition, structure, function, and ecosystem services.

Post-disturbance recovery is generally considered complete when the forest has returned to its pre-disturbance state (e.g., similar ecosystem structure and function). Forest recovery can be measured using many different kinds of indicators (Senf et al. 2019), including forest structural elements such as dead wood and coarse woody debris (Bolton et al. 2015; Bartels et al. 2016), floristic indicators (McLachlan and Bazely 2001; Nagel et al. 2006), biomass (Williams et al. 2014; Dobor et al. 2018), soil indicators such as fertility and nutrient pools (Martineau et al. 2019), and biodiversity, including diversity in soil (Jean et al. 2020), insects (Boulanger et al. 2013; Hammond et al. 2017), and bird communities (Azeria et al. 2011; Mayor et al. 2017).

Information about post-disturbance regeneration success and successional dynamics is critical to predict forest ecosystem resistance and resilience to subsequent disturbances and climate change (Millar et al. 2007; Stevens-Rumann et al.

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2022). A detailed understanding of post-disturbance recovery dynamics across Canadian biomes is needed to inform adaptive silviculture and management strategies that can mitigate the socio-ecological impacts of altered disturbance regimes, devise efficient carbon sequestration strategies, and ensure the provision of other ecosystem services, such as wood fibre. The Canadian Forest Service (CFS) is a part of Natural Resources Canada, a federal government department that has a mandate to "improve the quality of life of Canadians by ensuring the country's abundant natural resources are developed sustainably, competitively and inclusively" (Natural Resources Canada 2023). Understanding post-disturbance recovery aligns with CFS mandates and priorities, one of them being to conduct scientific research on forests that informs policy and forest management decisions, in support of sustainability. CFS research programs focus on forest management strategies to meet the economic, environmental, and social needs of Canadians.

Post-disturbance forest management actions implemented to facilitate forest tree recovery, such as plantation silviculture after wildfire events (Cyr et al. 2022), are an important part of mitigation and adaptation strategies to counter global change (Campbell et al. 2009). However, knowledge is needed to better understand the impacts of such mitigation actions on ecosystem services. For instance, some post-disturbance forest renewal practices can pose risks to biodiversity, such as understory vegetation communities or saproxylic beetle richness (Thorn et al. 2020). Mitigation actions to ensure forest recovery can also affect the social licence to operate, especially in regard to First Nations traditional land use and world view (Kayahara and Armstrong 2015). For instance, the use of chemical herbicide to support forest renewal and accelerate conifer dominance after harvesting is raising public apprehension regarding human health, potential ecological effects, as well as the rights and traditional activities of First Nations (Wyatt et al. 2011). Research is needed to develop the best possible guidance for post-disturbance forest management practices that support sustainability of ecosystem values and the socio-economic resilience of communities (Devisscher et al. 2021).

Post-disturbance ecosystem states are an integral part of Canada's forest landscapes and within CFS, research to understand and project trajectories of post-disturbance forest recovery is being undertaken by scientists. Field data collected from these studies are valuable at multiple scales. At the operational or stand scales, data are useful for assessing and refining forest management practices. At larger scales, data can be used to calibrate remotely sensed data products, parameterize ecosystem models, and forecast potential future forest conditions and carbon sequestration. At all scales, data and analyses can provide greater insight on post-disturbance recovery, which is a keystone to the sustainability of forests. Canada's National Forest Inventory (NFI) data collections from plots established after disturbances are another source used to characterize recovery (https://nfi.nfis.org/en). Some studies have also examined the relationship between forest structure and biodiversity as they relate to post-disturbance forest states (e.g., Venier et al. 2009; Porter et al. 2023). A few long-term studies have rich datasets that could be useful to other research teams. However, there is currently a need for a unified coherent vision that connects lines of inquiry and contributes to a larger, cohesive effort in the research community. Identifying key project linkages among CFS scientists and their collaborators would constitute a strong case study of post-disturbance recovery research and facilitate an improved understanding of the post-disturbance recovery of Canadian forests to better inform public policy and management decisions.

Our objective is to identify and classify post-disturbance empirical research conducted by the CFS and their collaborators. With this compilation and interpretation of CFS research studies, we aim to generate a better understanding of post-disturbance forest recovery in Canada and to provide guidance regarding future research needed to inform public policy and forest management decisions. Studies produced by the CFS constitute a subset of Canadian scientific literature on forest disturbance and recovery research. Focussing on CFS studies here has the benefit that the collated information can be readily integrated with CFS national-scale ecosystem modeling and remote sensing research (e.g., Henneb et al. 2021; White et al. 2022; White et al. 2023), facilitating a more coherent national blueprint for research on post-disturbance recovery. To situate the CFS within a broader context, we also examined the quantity of post-disturbance recovery studies conducted within the CFS from 1998 to 2020 and compared them with studies undertaken outside the CFS, but in Canada.

Materials and methods

Survey of CFS studies

Between 11 June 2020 and 15 January 2021, we searched peer-reviewed literature published in French and English between 1998 and 2020. Using Boolean search strings in the Scopus database, we identified articles whose subjects covered forest recovery, described studies conducted in Canada for which at least one author is affiliated with CFS, addressed natural or anthropogenic disturbances such as wildfires, insect outbreaks, diseases, windthrow, harvesting (including clearcutting, partial cutting, and salvage logging), or seismic lines, and that studied processes related to biodiversity, regeneration, succession, forest dynamics, soil, or tree growth (see Table A1 in Appendix A for details). We focussed our search on empirical field studies, excluding meta-analyses, reviews, invited commentaries, and studies based solely on modelling or remote sensing. Among these, we selected studies for which the time elapsed between a disturbance and the first recovery measurement was less than 30 years, which is about the time that has passed since initiation of the CFS-led NFI program. We also excluded studies that we could not access electronic copies of the full text, or with no clear descriptions of a disturbance or experimental design. We supplemented our search of published primary literature with internal or public government reports matching the same criteria as above, as well as published or unpublished databases which at least one author is affiliated with CFS. Based on the extent of Scopus coverage of the literature and including

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internal or public government reports, we have identified 181 studies conducted by the CFS that aligned with our inclusion criteria (Table S2).

Throughout this analysis, we used the following terminology: a **study** refers to any publication or document (primary research papers, governmental reports, and other unpublished source describing CFS research) matching our search criteria; and an **evidence point** is a punctual report of post-disturbance response(s) in a given study after a given disturbance. For example, a study (such as published research paper) based on surveys conducted on multiple sites corresponded to multiple evidence points in our database. Also, the same evidence point could be included in more than one study. An evidence point within a study can, for example, represent temporal redundancy when there are periodic measurements.

To evaluate how CFS post-disturbance recovery studies were representative of the Canadian research community, we also did a survey in the Scopus database, but for Canadian studies with a distinction of CFS and non-CFS affiliation. This survey was done by disturbance and by year between 1998 and 2020 (see Table A2 in Appendix A for research strings).

Data synthesis

For our CFS studies analysis, we grouped disturbances as natural (biotic or abiotic) or anthropogenic (forest management and silviculture). Abiotic disturbances included fire (wildfire and prescribed fire), windthrow, drought, and gap dynamics. Biotic disturbances included insect outbreaks and plant diseases. Forest management included various categories of forest management and silvicultural practices (clearcut, partial cutting, salvage logging, biomass harvest, and site preparation) and natural resource extraction (oil sands mining, open pit mining, cutline, other mining, and creation of seismic lines for oil and gas exploration). For each study, we classified response variables into five categories (soil, vegetation, fauna, hydrology, and microbial communities) (see Table S1 in Supplementary material). We projected the coordinates of evidence points on Canadian forest vegetation zones (Baldwin et al. 2021) (Fig. 2). To generate a better understanding of post-disturbance forest recovery in Canada and offer insights into future research needed, we summarized the data in alluvial diagrams using the RAW Graphs software tools (https://rawgraphs.io/), per disturbance type.

Results and discussion

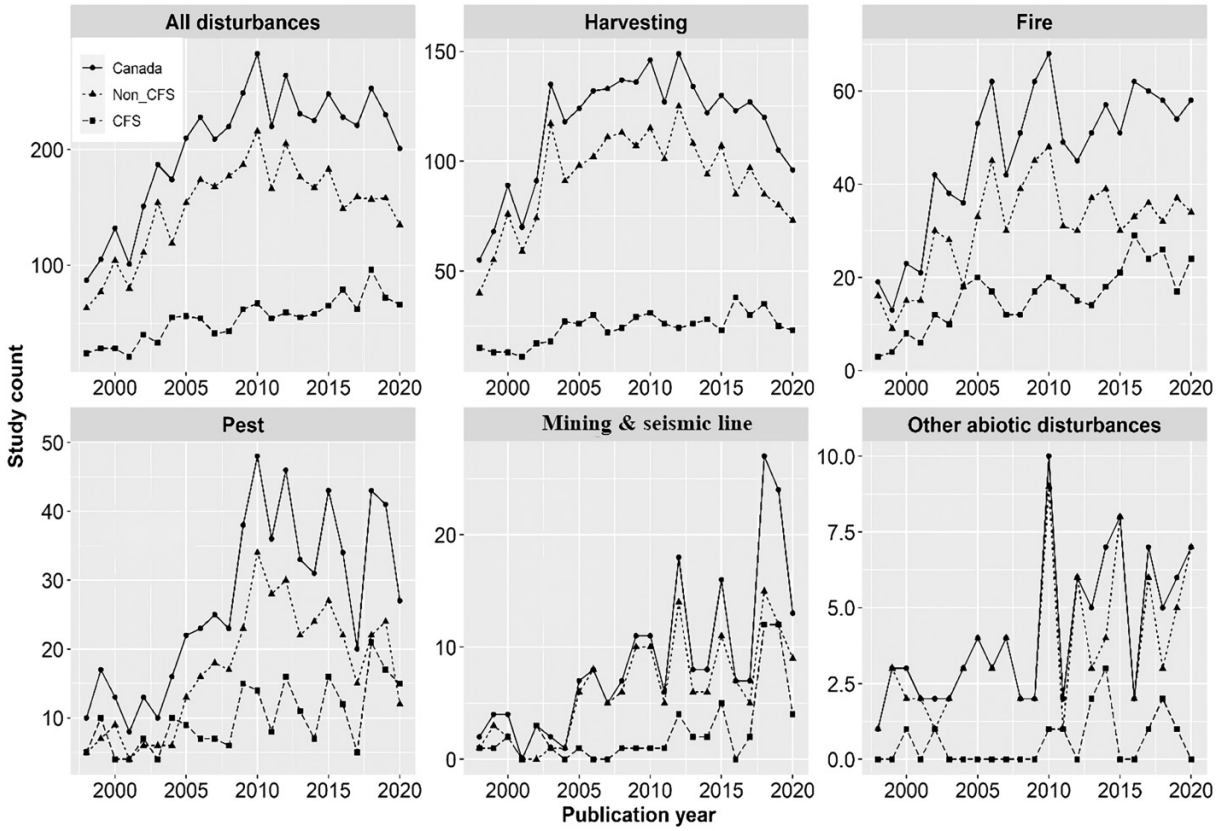
After forest disturbance, the capacity and the time required to recover to the pre-disturbance state are two important indicators of ecosystem resilience (Scheffer et al. 2015; Seidl et al. 2016). The early phase of recovery and the factors driving its success are still only partly understood. This early phase is a successional stage during which tree species are being recruited and re-establishing after the occurrence of a disturbance (natural or human-caused). From a forest cover perspective, this stage lasts until seedlings and saplings have become young trees, i.e., until a forested ecosystem is re-established. Therefore, it ends when the stand structure corresponds to the stem exclusion phase (sensu Oliver and Larson 1996) or after the re-establishment of a tree cover similar to pre-disturbance conditions (Franklin et al. 2002; Swanson et al. 2011). During this early phase, the abiotic and biotic environment change more or less rapidly with rapid turnover of species (notably insects, birds, and understory plant species), changes in nutrient fluxes and pools, alteration of hydrological and geomorphic regimes (Swanson et al. 2011), and changes in the amount of coarse woody debris, among others things. Post-disturbance recovery entails understanding the connections between disturbances and the subsequent regrowth of forests, often expressed through successional dynamics. The process of forest succession relies on the interactions between abiotic and biotic factors, while also being influenced by pre-existing characteristics such as forest tree and understory composition. Forest succession can follow multiple pathways depending on disturbance timing, extent, type, severity, and resource availability. Here, we present the findings from our analysis of the CFS literature, followed by an evidence-based discussion on post-disturbance forest recovery.

CFS studies

Since 1998, the number of studies on post-disturbance in Canada has increased (Fig. 1). Non-CFS literature represented the highest proportion of post-disturbance recovery studies for all disturbances. For example, Bartels and Macdonald (2023) evaluated the impact of retention harvesting on understory biodiversity and Yang and Man (2018) studied the impacts of partial harvesting on tree diversity and stand structure. The understory vegetation and tree responses after fire and pest outbreak were evaluated (Edwards et al. 2015), as well as the impact of insect outbreaks on post-disturbance dynamics (Sanchez-Pinillos et al. 2019). However, the representativeness of CFS post-disturbance recovery studies within all Canadian studies remains relatively high and this trend has increased over time (Fig. 1). When considering all disturbances together, we found that CFS studies represented more than 30% of all studies since 2018. Wildfire is the disturbance for which CFS had the largest proportion of studies in Canada, which increased over time, going from 15% of the post-fire recovery studies in 1998 to 41% in 2020. For forest management, however, CFS studies were only a small part of all surveyed studies, with no clear increase over time, representing 23% of all the Canadian studies in 2020 (Fig. 1).

We identified 181 CFS studies of post-disturbance forest recovery that were published, submitted, or in preparation for submission between 1998 and 2020 (Table S2). In some studies, more than one disturbance was included. These studies comprised 860 evidence points. Evidence points were more frequent in Quebec, Ontario, and Alberta forests than in British Columbia, Saskatchewan, Manitoba, and Atlantic provinces and territories (Fig. 2), and were concentrated in the Boreal Forest and Woodland (144), Eastern Cool Temperate Forest (27), and Cordilleran Cool Temperate Forest (10) vegetation zones (Fig. 2; Table S2). Post-fire evidence points

Fig. 1. Global studies in Canada and in Canadian Forest Service (CFS) on post-fire, or post-harvest, or post-insect outbreak recovery (see Table A2 in Appendix for specific research strings).



were mostly found in Quebec, Alberta, and the Northwest Territories, with few studies in other provinces. Post-harvest evidence points were mostly concentrated in Alberta, Quebec, and Ontario (Fig. 2).

Forest management and silvicultural practices, including harvest, reforestation, and stand preparation, were the most extensively studied disturbances in CFS research. They accounted for 90% of the CFS studies (166 studies out of 181) and over half of the evidence points (530), surpassing other disturbances such as fire, which had 77 studies and approximately a quarter of the evidence points (Fig. 3). Studies on recovery after pest disturbances were less common (23 studies, with 66 evidence points). Other abiotic disturbances were uncommon in CFS-produced literature (10 studies, with 56 evidence points). Most of the studies were conducted within the first 15 years after the disturbances; 26% of the studies, all disturbances combined, were undertaken the first 5 years after disturbance, 47% the first 10 years, and 69% the first 15 years (see Fig. A1 in Appendix A).

The geographic distribution of studies and the relative importance of disturbances is likely a combined effect of accessibility, frequency, and predictability of disturbances. For example, in addition to being predictable over periods that generally vary between 1 and 5 years, as outlined in forest management plans, forest management activities include the establishment and maintenance of road networks that enable harvesting, forest renewal treatments, and stand tending as well as access to research sites. Wildfires are less predictable than forest management activities, but they are a major annual driver of boreal ecosystem dynamics, having affected more than 4 million hectares in 2021 (National Forestry Database 2022). While about 16 million hectares of forest were affected by pests annually in Canada between 1998 and 2020 (National Forestry Database 2022), they are clearly underrepresented in terms of research efforts in the CFS and beyond.

In the CFS-produced literature, most of the post-disturbance response variables studied were related to vegetation (70%), mainly tree regeneration and plant physiology and nutrition (Fig. 4A). For example, Ménard et al. (2019) documented the short-term abundance and composition of tree regeneration and competing vegetation over a large area in boreal Quebec following careful logging operations. Understory species diversity and regeneration were also well covered in the literature we have assembled. For example, Fleming and Baldwin (2008) have examined the initial impacts of partial and total harvesting and soil disturbance on plant community responses in a tolerant hardwood forest in Ontario. Soil chemical characteristics were the main soil variables studied after forest management and fauna diversity was the main research focus in the wildlife category. For example, Venier et al. (2015) evaluated how the retention of aggregate trees served as mature habitat for forest birds in a harvested matrix of boreal mixedwood stands. Finally,

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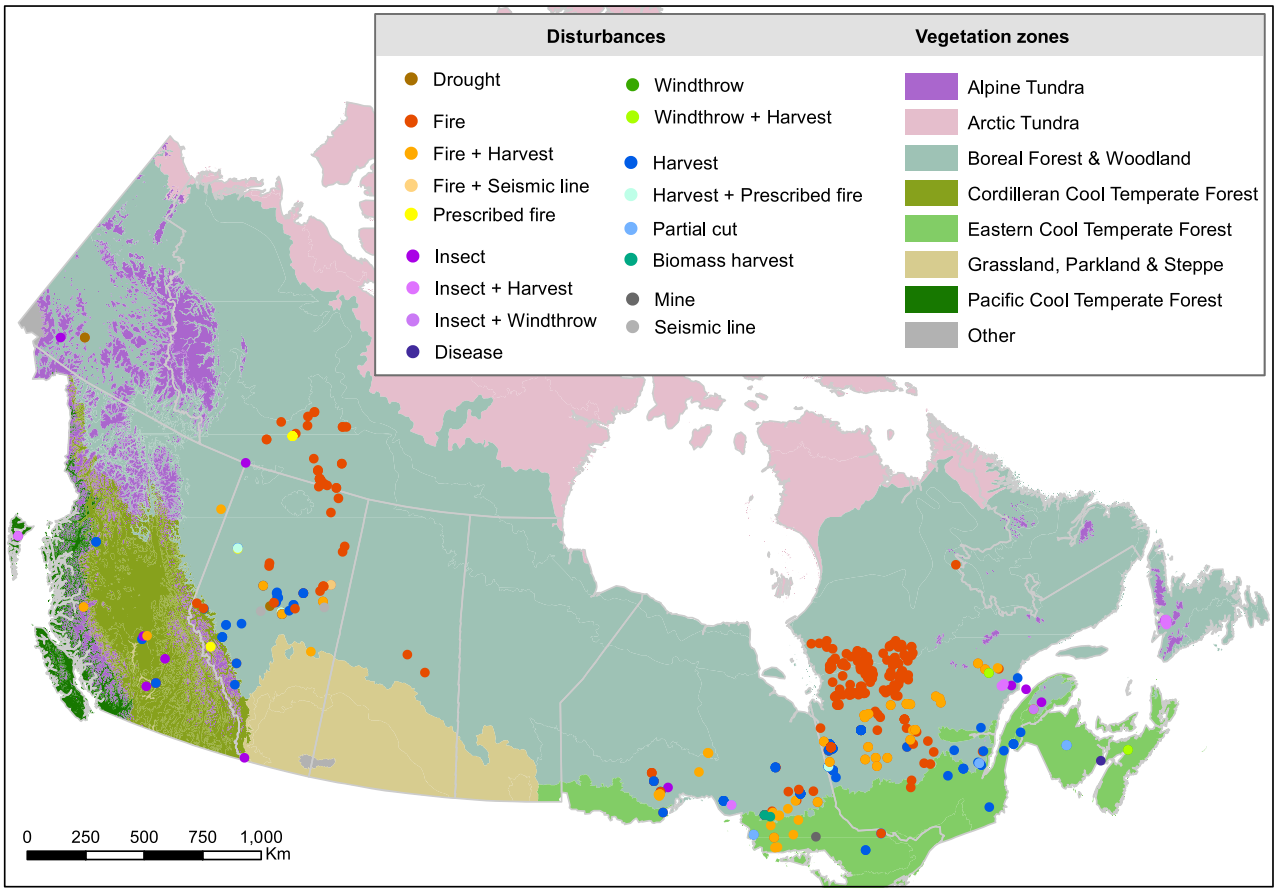
Fig. 2. Distribution of the Canadian Forest Service evidence points on post-disturbance forest recovery across Canadian vegetation zones, based on published and unpublished studies carried out between 1998 and 2020. Refer to Table S2 for a list of studies. Figure was created using ArcMap version 10.5.1. Canadian vegetation zones were extracted from The Canadian Open Government website: https://open.canada.ca/data/en/dataset/22b0166b-9db3-46b7-9baf-6584a3acc7b1.



studies including hydrological and microbial community variables remained sparse (5% and 2%, respectively).

Variables studied after fire disturbances were similar to those investigated following forest management (Fig. 4B). Vegetation-related variables were particularly dominant (77%), followed by faunal, soil, and microbial community variables (12%, 11%, and <1%, respectively). For example, Whitman et al. (2019) studied how short-interval reburns in upland and wetland environments of northwestern Canada impacted tree recruitment and resulting densities, as well as soil organic layer thickness and herbaceous vegetation cover. Tree regeneration was the most studied post-fire process, followed by plant physiology and nutrient. We found no CFS studies that examined post-fire hydrology.

Most of the variables studied after pest disturbances were vegetation-related (94%) and few were related to fauna (6%) and soil (6%) (Fig. 4C). For example, Nealis and Turnquist (2010) studied the recovery of juvenile western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) stands 5 years after the end of an outbreak of western blackheaded budworm and hemlock sawfly in British Columbia, while Venier et al. (2009) examined the influence of a spruce budworm outbreak on the bird community of boreal mixedwood forests in Ontario. Trajectories of forest canopy recovery following bark beetle outbreaks was studied in British Columbia (Campbell and Antos 2015). For other disturbances, including windthrow, gap dynamics, and drought, the majority (86%) of studied response variables were related to vegetation, tree regeneration, and deadwood (Fig. 4D). For example, using field data collected in 150 plots in central and western Canada, Hogg et al. (2008) studied the impacts of a severe drought on trembling aspen (*Populus tremuloides* Michx.) forests. Few variables related to soil (4%) were studied following windthrow, gap dynamics, and drought. We did not find any CFS studies examining the effects of wind, gap, or drought disturbances on fauna, hydrology, and microbial community. Overall, we observed that response variables related to vegetation were the most studied within the CFS, a result of them being closely linked to the CFS mandate and the department research programs. While soil processes and hydrology are also part of CFS programs, they were underrepresented in the literature we have collected.

Conclusion and perspectives

With this analysis, we identified and classified post-disturbance empirical research conducted by CFS scientists

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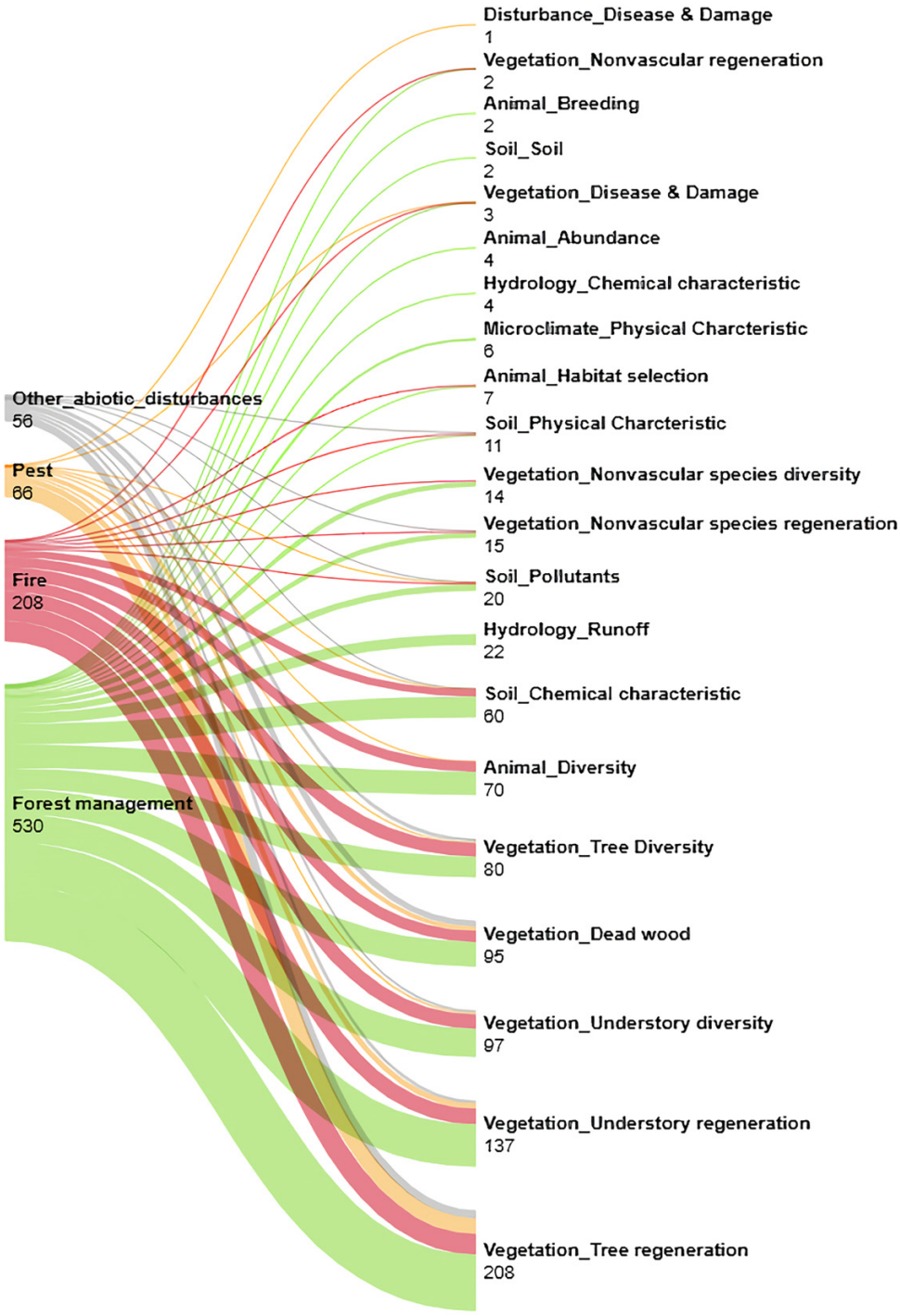
Fig. 3. Disturbance type (left) and early recovery ecological response variable and process (right) studies in the Canadian Forest Service (CFS) inventoried studies. Each colour represents a disturbance type; bands' width and numbers correspond to evidence points. The wider the band, the more common the disturbance + variable combination in the scientific literature involving CFS researchers. Forest management included categories of forest harvesting methods (clearcut, partial cutting, salvage logging, biomass harvest, site preparation, oil sand mining, open pit mining, cutline, and mine), fire (wildfire and prescribed fire), pest (insect outbreak and plant diseases), and other abiotic disturbances (windthrow, drought, and gap dynamics).



and their collaborators to generate a better understanding of post-disturbance forest recovery in Canada and to provide guidance regarding future research needed to inform public policy and forest management decisions. Our analysis revealed that research focusing on recovery after natural disturbances appeared to be relatively underrepresented in the assessed literature compared to studies centered around harvesting. This points to an important gap in CFS research on forest recovery, especially in view of a trajectory towards more active fire regimes (Hanes et al. 2019) fuelled by climate

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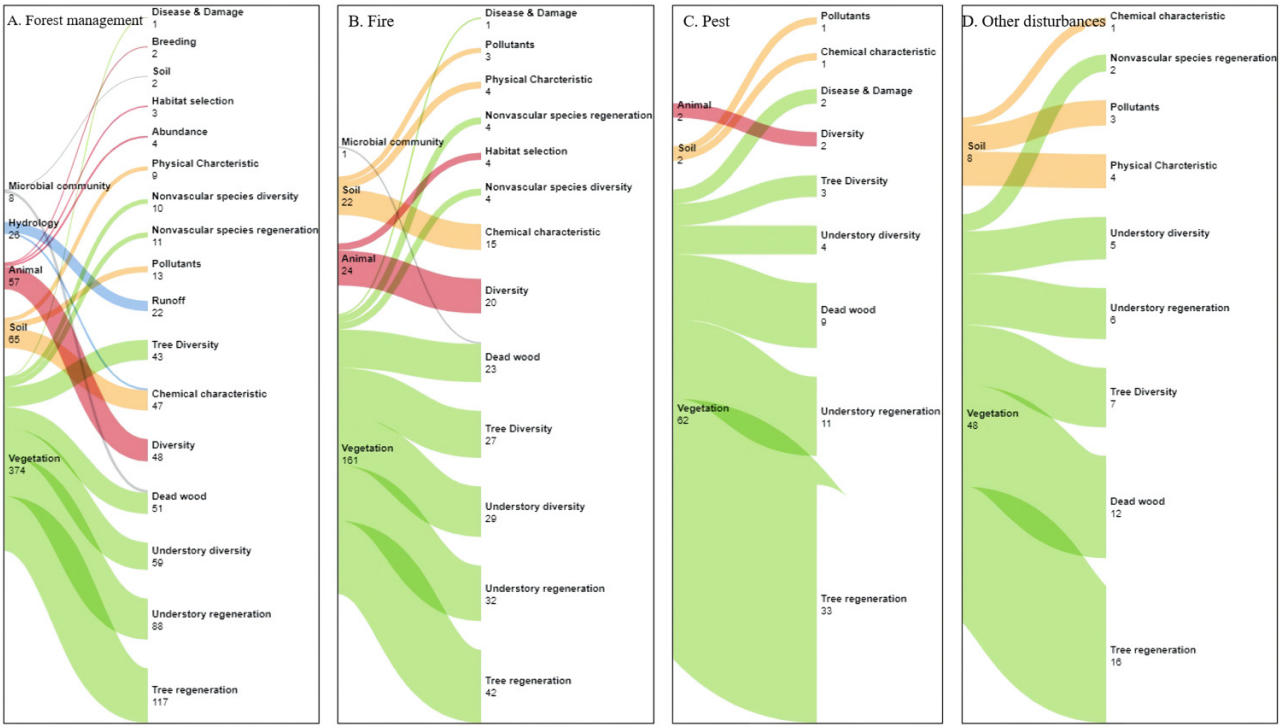
Fig. 4. Distribution of (A) forest management (included categories of forest harvesting methods: clearcut, partial cutting, salvage logging, biomass harvest, site preparation, oil sand mining, open pit mining, cutline, and mine); (B) fire (wildfire and prescribed fire); (C) pest (insect outbreak and plant diseases); and (D) other abiotic disturbances (windthrow, drought, and gap dynamics) studies conducted by the Canadian Forest Service that have investigated ecological responses of post-disturbed forest early recovery (left). Each colour represents an ecological response; bands' width and numbers correspond to evidence points. The wider the band, the more common the disturbance + variable combination in the scientific literature involving CFS researchers. Detailed responses or processes are listed to the right.



change (Gillett et al. 2004; Kirchmeier-Young et al. 2019) and of an increase in the establishment and spread of invasive pests due to global warming (Robinet and Roques 2010). A better understanding of how forest recovery responds to varying climatic, soil, and topographic conditions will be crucial for accurate projections of reforestation efforts needed across Canadian landscapes, as well as for determining silviculture methods and costs (Marshall et al. 2023). This highlights a gap in research coverage that warrants attention and further investigation. Understanding and addressing the impacts of pests, wind events, climate change, and social dimensions are vital components for comprehensive and sustainable forest management practices. Incorporating these aspects into post-disturbance recovery research is necessary to provide a more holistic understanding of ecosystem resilience, adaptive management strategies, and the socio-ecological implications of forest disturbances.

Although forest management was a main focus of the post-disturbance recovery research that we identified between 1998 and 2020, its proportion within CFS was limited. Forest regeneration after harvesting faces obstacles, especially in the context of climate change. For instance, preserving seed and propagule sources on site during harvesting operations has been crucial to ensure natural stand renewal. However, the effects of rising temperatures and drought can disrupt seed production for numerous species (Kabrick et al. 2017). Moreover, local genetic variations might not be well-suited to future climate conditions, potentially impacting the capacity of new forests to provide ecosystem services in the future (Boisvert-Marsh et al. 2022). Damage to established regeneration (Thiffault et al. 2023), management of woody debris and its procurement for biomass, or encroachment by invasive (Labonté et al. 2020) or native (Thiffault et al. 2013) competing species can also impede recovery following forest management. Moreover, due to changing environmental conditions, disturbance patterns, and species composition, there is still much we do not know about how consecutive disturbances (such as fire followed by salvage harvest) impact post-disturbance recovery (Anyomi et al. 2022). There is a need to develop adaptive silviculture approaches that will ensure successful post-harvest recovery (Achim et al. 2022). As a national body committed to support the development of sustainable forest management practices in all of Canada's regions, CFS research efforts to understand recovery after forest management practices should be maintained, especially in ecosystems and regions that are underrepresented (Fig. 2).

Moreover, Canadian forests are managed under a natural disturbance paradigm (Venier et al. 2014), which requires a deep understanding of how forests recover from natural disturbance as a baseline or reference condition against which to measure forest management. Many studies examine convergence with the expectation that, over time, forests from

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natural versus harvest disturbance will eventually converge on common composition, structure, and function (Bittleston et al. 2016). However, convergence does not address the importance of differences in composition, structure, and function throughout succession. A thorough understanding of the complete successional trajectory from disturbance to recovery after natural disturbance is necessary. These studies should include not only long-term research sites, but also chronosequence studies that substitute space for time (e.g., Wardle et al. 2012; Porter et al. 2023).

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Data availability
The list of studies compiled in this analysis is provided in Table S2. No other datasets were generated or analyzed during the current study.

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Supplementary material

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APPENDIX A

Table A1. Keywords researched in Scopus for the CFS post-disturbance recovery studies.

Population	Language	Scopus query	Field codes
Subject	English	"forest AND recovery"	TITLE OR KEY
	French	"forêt AND Régénération"	TITLE OR KEY
Country		Canada	TITLE OR KEY
Affiliation	English	"Canadian Forest Service" OR CFS OR "Atlantic Forestry Cent∗" OR AFC OR "Canadian Wood Fibre Cent∗" OR CWFC OR "Great Lakes Forestry Cent∗" OR GLFC OR "Laurentian Forestry Cent∗" OR LFC OR "Northern Forestry Cent∗" OR NoFC OR " Pacific Forestry Cent∗" OR PFC	AFFILORG
	French	"Service Canadien des forêts" OR SCF OR "Centre de Foresterie de l'Atlantique" OR CFA OR "Centre canadien sur la fibre de bois" OR CCFB OR "Centre de foresterie des Grands Lacs" OR CFGL OR "Centre de foresterie des Laurentides" OR CFL OR "Centre de foresterie du Nord" OR CFN OR "Centre de foresterie du Pacifique" OR CFP	AFFILORG
Exposure/Intervention			
Disturbance	English	"Forest AND Disturbance" OR "forest AND fire" OR "forest AND wildfire" OR "forest AND burn∗" OR "forest AND outbreak" OR "forest AND spruce budworm" OR "forest AND Montain pine beetle" OR "forest AND hemlock looper" OR "forest AND pest" OR "forest AND disease" OR "forest AND Harvest∗" OR "forest AND Clearcut∗" OR "forest AND Clear cut∗" OR "forest AND cut∗" OR "forest AND Partial cut∗" OR "forest AND log∗" OR "forest AND salvage log∗" OR "silviculture"	TITLE OR KEY
		OR "forest AND windthrow" OR "forest AND seismic line"	
	French	"forêt AND Perturbation" OR "forêt AND feu" OR "forêt AND épidémie" OR "forêt AND dendroctone" OR "forêt AND tordeuse" OR "forêt AND arpenteuse de la pruche" OR "forêt AND maladie" OR "forêt AND peste" OR "forêt AND coupe∗" OR "forêt AND Chablis" OR "forêt AND ligne sismique"	TITLE OR KEY
Outcome			
Studied process	English	"forest AND Biodiversity" OR "forest AND animal" OR "forest AND seedling∗" OR "forest AND sapling∗" OR "forest AND soil∗" OR "forest AND bird∗" OR "forest AND Biomass" OR "forest AND succession" OR "forest AND Understory" OR "forest AND Dynamic" OR "forest AND Growth" OR "forest AND insect" OR "forest AND organism"	TITLE OR KEY
	French	"forêt AND Biodiversité" OR "forêt AND animal" OR "forêt AND semis" OR "forêt AND gaulis" OR "forêt AND sol" OR "forêt AND oiseau" OR "forêt AND biomasse" OR "forêt AND sous-bois" OR "forêt AND succession" OR "forêt AND dynamique" OR "forêt AND croissance" OR "forêt AND insect" OR "forêt AND organisme"	TITLE OR KEY

The asterisk (∗) is used to represent any group of characters, including no character, and boolean operator "AND" is used to combine the five categories.

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Table A2. Keywords researched in Scopus for studies in Canada from 1998 to 2020, including both global studies in Canada and within the Canadian Forest Service (CFS) on post-disturbance recovery.

Disturbance	Origin	Scopus query
Fire	Canada	Q1: (KEY (forest AND fire) OR KEY (forest AND wildfire) OR KEY (forest AND burn*) OR KEY (forêt AND feu) OR TITLE (forest AND fire) OR TITLE (forest AND wildfire) OR TITLE (forest AND burn*) OR TITLE (forêt AND feu)) AND (KEY (forest AND recovery) OR KEY (forêt AND Régénération) OR KEY (forest AND Biodiversity) OR KEY (forest AND animal) OR KEY (forest AND seedling*) OR KEY (forest AND sapling*) OR KEY (forest AND soil*) OR KEY (forest AND bird*) OR KEY (forest AND Biomass) OR KEY (forest AND succession) OR KEY (forest AND Understory) OR KEY (forest AND Dynamic) OR KEY (forest AND Growth) OR KEY (forest AND insect) OR KEY (forest AND organism) OR KEY (forêt AND Biodiversité) OR KEY (forêt AND animal) OR KEY (forêt AND semis) OR KEY (forêt AND gaulis) OR KEY (forêt AND sol) OR KEY (forêt AND oiseau) OR KEY (forêt AND biomasse) OR KEY (forêt AND sous-bois) OR KEY (forêt AND succession) OR KEY (forêt AND dynamique) OR KEY (forêt AND croissance) OR KEY (forêt AND insect) OR KEY (forêt AND organisme) OR KEY (Canada) OR KEY (boreal*) OR KEY (boréal*) OR TITLE (forest AND recovery) OR TITLE (forêt AND Régénération) OR TITLE (Forest AND Disturbance) OR TITLE (forêt AND Perturbation) OR TITLE (forest AND Biodiversity) OR TITLE (forest AND animal) OR TITLE (forest AND seedling*) OR TITLE (forest AND sapling*) OR TITLE (forest AND soil*) OR TITLE (forest AND bird*) OR TITLE (forest AND Biomass) OR TITLE (forest AND succession) OR TITLE (forest AND Understory) OR TITLE (forest AND Dynamic) OR TITLE (forest AND Growth) OR TITLE (forest AND insect) OR TITLE (forest AND organism) OR TITLE (forêt AND Biodiversité) OR TITLE (forêt AND animal) OR TITLE (forêt AND semis) OR TITLE (forêt AND gaulis) OR TITLE (forêt AND sol) OR TITLE (forêt AND oiseau) OR TITLE (forêt AND biomasse) OR TITLE (forêt AND sous-bois) OR TITLE (forêt AND succession) OR TITLE (forêt AND dynamique) OR TITLE (forêt AND croissance) OR TITLE (forêt AND insect) OR TITLE (forêt AND organisme) OR TITLE (Canada) OR TITLE (boreal*) OR TITLE (boréal*)) AND AFFILCOUNTRY(Canada) AND PUBYEAR IS 1998 AND SUBJAREA(AGRI)
	CFS	Q2: (KEY (forest AND fire) OR KEY (forest AND wildfire) OR KEY (forest AND burn*) OR KEY (forêt AND feu) OR TITLE (forest AND fire) OR TITLE (forest AND wildfire) OR TITLE (forest AND burn*) OR TITLE (forêt AND feu)) AND (KEY (forest AND recovery) OR KEY (forêt AND Régénération) OR KEY (forest AND Biodiversity) OR KEY (forest AND animal) OR KEY (forest AND seedling*) OR KEY (forest AND sapling*) OR KEY (forest AND soil*) OR KEY (forest AND bird*) OR KEY (forest AND Biomass) OR KEY (forest AND succession) OR KEY (forest AND Understory) OR KEY (forest AND Dynamic) OR KEY (forest AND Growth) OR KEY (forest AND insect) OR KEY (forest AND organism) OR KEY (forêt AND Biodiversité) OR KEY (forêt AND animal) OR KEY (forêt AND semis) OR KEY (forêt AND gaulis) OR KEY (forêt AND sol) OR KEY (forêt AND oiseau) OR KEY (forêt AND biomasse) OR KEY (forêt AND sous-bois) OR KEY (forêt AND succession) OR KEY (forêt AND dynamique) OR KEY (forêt AND croissance) OR KEY (forêt AND insect) OR KEY (forêt AND organisme) OR KEY (Canada) OR KEY (boreal*) OR KEY (boréal*) OR TITLE (forest AND recovery) OR TITLE (forêt AND Régénération) OR TITLE (Forest AND Disturbance) OR TITLE (forêt AND Perturbation) OR TITLE (forest AND Biodiversity) OR TITLE (forest AND animal) OR TITLE (forest AND seedling*) OR TITLE (forest AND sapling*) OR TITLE (forest AND soil*) OR TITLE (forest AND bird*) OR TITLE (forest AND Biomass) OR TITLE (forest AND succession) OR TITLE (forest AND Understory) OR TITLE (forest AND Dynamic) OR TITLE (forest AND Growth) OR TITLE (forest AND insect) OR TITLE (forest AND organism) OR TITLE (forêt AND Biodiversité) OR TITLE (forêt AND animal) OR TITLE (forêt AND semis) OR TITLE (forêt AND gaulis) OR TITLE (forêt AND sol) OR TITLE (forêt AND oiseau) OR TITLE (forêt AND biomasse) OR TITLE (forêt AND sous-bois) OR TITLE (forêt AND succession) OR TITLE (forêt AND dynamique) OR TITLE (forêt AND croissance) OR TITLE (forêt AND insect) OR TITLE (forêt AND organisme) OR TITLE (Canada) OR TITLE (boreal*) OR TITLE (boréal*)) AND AFFILCOUNTRY(Canada) AND PUBYEAR IS 1998 AND SUBJAREA(AGRI) AND (AFFILORG(Canadian Forest Service) OR AFFILORG (CFS) OR AFFILORG (Atlantic Forestry Cent*) OR AFFILORG (AFC) OR AFFILORG (Canadian Wood Fibre Cent*) OR AFFILORG (CWFC) OR AFFILORG (Great Lakes Forestry Cent*) OR AFFILORG (GLFC) OR AFFILORG (Laurentian Forestry Cent*) OR AFFILORG (LFC) OR AFFILORG (Northern Forestry cent*) OR AFFILORG (Service Canadien des forêts) OR AFFILORG (SCF) OR AFFILORG (Centre de Foresterie de l'Atlantique) OR AFFILORG (CFA) OR AFFILORG (Centre canadien sur la fibre de bois) OR AFFILORG (CCFB) OR AFFILORG (Centre de foresterie des Grands Lacs) OR AFFILORG (CFGL) OR AFFILORG (Centre de foresterie des Laurentides) OR AFFILORG (CFL) OR AFFILORG (Centre de foresterie du Nord) OR AFFILORG (CFN) OR AFFILORG (Centre de foresterie du Pacifique) OR AFFILORG (CFP))
Forest management	Canada	Q1: (KEY (forest AND Harvest) OR KEY (forest AND Clearcut*) OR (forest AND Clear cut*) OR KEY (forest AND cut*) OR KEY (forest AND Partial cut*) OR KEY (forest AND log*) OR KEY (forest AND salvage log*) OR KEY (silviculture) OR TITLE (forest AND Harvest) OR TITLE (forest AND Clearcut*) OR (forest AND Clear cut*) OR TITLE (forest AND cut*) OR TITLE (forest AND Partial cut*) OR TITLE (forest AND log*) OR TITLE (forest AND salvage log*) OR TITLE (silviculture)) AND (KEY (forest AND recovery) OR KEY (forêt AND Régénération) OR KEY (forest AND Biodiversity) OR KEY (forest AND animal) OR KEY (forest AND seedling*) OR KEY (forest AND sapling*) OR KEY (forest AND soil*) OR KEY (forest AND bird*) OR KEY (forest AND Biomass) OR KEY (forest AND succession) OR KEY (forest AND Understory) OR KEY (forest AND Dynamic) OR KEY (forest AND Growth) OR KEY (forest AND insect) OR KEY (forest AND organism) OR KEY (forêt AND Biodiversité) OR KEY (forêt AND animal) OR KEY (forêt AND semis) OR KEY (forêt AND gaulis) OR KEY (forêt AND sol) OR KEY (forêt AND oiseau) OR KEY (forêt AND biomasse) OR KEY (forêt AND sous-bois) OR KEY (forêt AND succession) OR KEY (forêt AND dynamique) OR KEY (forêt AND croissance) OR KEY (forêt AND insect) OR KEY (forêt AND organisme) OR KEY (Canada) OR KEY (boreal*) OR KEY (boréal*) OR TITLE (forest AND recovery) OR TITLE (forêt AND Régénération) OR TITLE (Forest AND Disturbance) OR TITLE (forêt AND Perturbation) OR TITLE (forest AND Biodiversity) OR TITLE (forest AND animal) OR TITLE (forest AND seedling*) OR TITLE (forest AND sapling*) OR TITLE (forest AND soil*) OR TITLE (forest AND bird*) OR TITLE (forest AND Biomass) OR TITLE (forest AND succession) OR TITLE (forest AND Understory) OR TITLE (forest AND Dynamic) OR TITLE (forest AND Growth) OR TITLE (forest AND insect) OR TITLE (forest AND organism)

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Table A2. (*continued*).

Disturbance	Origin	Scopus query
		OR TITLE (forêt AND Biodiversité) OR TITLE (forêt AND animal) OR TITLE (forêt AND semis) OR TITLE (forêt AND gaulis) OR TITLE (forêt AND sol) OR TITLE (forêt AND oiseau) OR TITLE (forêt AND biomasse) OR TITLE (forêt AND sous-bois) OR TITLE (forêt AND succession) OR TITLE (forêt AND dynamique) OR TITLE (forêt AND croissance) OR TITLE (forêt AND insect) OR TITLE (forêt AND organisme) OR TITLE (Canada) OR TITLE (boreal∗) OR TITLE (boréal∗)) AND AFFILCOUNTRY(Canada) AND PUBYEAR IS 1998 AND SUBJAREA(AGRI)
	CFS	Q2: (KEY (forest AND Harvest) OR KEY (forest AND Clearcut∗) OR (forest AND Clear cut∗) OR KEY (forest AND cut∗) OR KEY (forest AND Partial cut∗) OR KEY (forest AND log∗) OR KEY (forest AND salvage log∗) OR KEY (silviculture) OR TITLE (forest AND Harvest) OR TITLE (forest AND Clearcut∗) OR (forest AND Clear cut∗) OR TITLE (forest AND cut∗) OR TITLE (forest AND Partial cut∗) OR TITLE (forest AND log∗) OR TITLE (forest AND salvage log∗) OR TITLE (silviculture)) AND (KEY (forest AND recovery) OR KEY (forêt AND Régénération) OR KEY (forest AND Biodiversity) OR KEY (forest AND animal) OR KEY (forest AND seedling∗) OR KEY (forest AND sapling∗) OR KEY (forest AND soil∗) OR KEY (forest AND bird∗) OR KEY (forest AND Biomass) OR KEY (forest AND succession) OR KEY (forest AND Understory) OR KEY (forest AND Dynamic) OR KEY (forest AND Growth) OR KEY (forest AND insect) OR KEY (forest AND organism) OR KEY (forêt AND Biodiversité) OR KEY (forêt AND animal) OR KEY (forêt AND semis) OR KEY (forêt AND gaulis) OR KEY (forêt AND sol) OR KEY (forêt AND oiseau) OR KEY (forêt AND biomasse) OR KEY (forêt AND sous-bois) OR KEY (forêt AND succession) OR KEY (forêt AND dynamique) OR KEY (forêt AND croissance) OR KEY (forêt AND insect) OR KEY (forêt AND organisme) OR KEY (Canada) OR KEY (boreal∗) OR KEY (boréal∗) OR TITLE (forest AND recovery) OR TITLE (forêt AND Régénération) OR TITLE (Forest AND Disturbance) OR TITLE (forêt AND Perturbation) OR TITLE (forest AND Biodiversity) OR TITLE (forest AND animal) OR TITLE (forest AND seedling∗) OR TITLE (forest AND sapling∗) OR TITLE (forest AND soil∗) OR TITLE (forest AND bird∗) OR TITLE (forest AND Biomass) OR TITLE (forest AND succession) OR TITLE (forest AND Understory) OR TITLE (forest AND Dynamic) OR TITLE (forest AND Growth) OR TITLE (forest AND insect) OR TITLE (forest AND organism) OR TITLE (forêt AND Biodiversité) OR TITLE (forêt AND animal) OR TITLE (forêt AND semis) OR TITLE (forêt AND gaulis) OR TITLE (forêt AND sol) OR TITLE (forêt AND oiseau) OR TITLE (forêt AND biomasse) OR TITLE (forêt AND sous-bois) OR TITLE (forêt AND succession) OR TITLE (forêt AND dynamique) OR TITLE (forêt AND croissance) OR TITLE (forêt AND insect) OR TITLE (forêt AND organisme) OR TITLE (Canada) OR TITLE (boreal∗) OR TITLE (boréal∗)) AND AFFILCOUNTRY(Canada) AND PUBYEAR IS 1998 AND SUBJAREA(AGRI) AND (AFFILORG(Canadian Forest Service) OR AFFILORG (CFS) OR AFFILORG (Atlantic Forestry Cent∗) OR AFFILORG (AFC) OR AFFILORG (Canadian Wood Fibre Cent∗) OR AFFILORG (CWFC) OR AFFILORG (Great Lakes Forestry Cent∗) OR AFFILORG (GLFC) OR AFFILORG (Laurentian Forestry Cent∗) OR AFFILORG (LFC) OR AFFILORG (Northern Forestry cent∗) OR AFFILORG (Service Canadien des forêts) OR AFFILORG (SCF) OR AFFILORG (Centre de Foresterie de l'Atlantique) OR AFFILORG (CFA) OR AFFILORG (Centre canadien sur la fibre de bois) OR AFFILORG (CCFB) OR AFFILORG (Centre de foresterie des Grands Lacs) OR AFFILORG (CFGL) OR AFFILORG (Centre de foresterie des Laurentides) OR AFFILORG (CFL) OR AFFILORG (Centre de foresterie du Nord) OR AFFILORG (CFN) OR AFFILORG (Centre de foresterie du Pacifique) OR AFFILORG (CFP))
Pest	Canada	Q1: (TITLE (forest AND outbreak) OR TITLE (forest AND spruce budworm) OR TITLE (forest AND Montain pine beetle) OR TITLE (forest AND hemlock looper) OR TITLE (forest AND pest) OR TITLE (forêt AND dendroctone) OR TITLE (forêt AND tordeuse) OR TITLE (forêt AND dendroctone) OR TITLE (forêt AND arpenteuse de la pruche) OR TITLE (forest AND disease) OR TITLE (forêt AND maladie) OR TITLE (forêt AND peste) OR KEY (forest AND outbreak) OR KEY (forest AND spruce budworm) OR KEY (forest AND Montain pine beetle) OR KEY (forest AND hemlock looper) OR KEY (forest AND pest) OR KEY (forêt AND dendroctone) OR KEY (forêt AND tordeuse) OR KEY (forêt AND dendroctone) OR KEY (forêt AND arpenteuse de la pruche) OR KEY (forest AND disease) OR KEY (forêt AND maladie) OR KEY (forêt AND peste)) AND (KEY (forest AND recovery) OR KEY (forêt AND Régénération) OR KEY (forest AND Biodiversity) OR KEY (forest AND animal) OR KEY (forest AND seedling∗) OR KEY (forest AND sapling∗) OR KEY (forest AND soil∗) OR KEY (forest AND bird∗) OR KEY (forest AND Biomass) OR KEY (forest AND succession) OR KEY (forest AND Understory) OR KEY (forest AND Dynamic) OR KEY (forest AND Growth) OR KEY (forest AND insect) OR KEY (forest AND organism) OR KEY (forêt AND Biodiversité) OR KEY (forêt AND animal) OR KEY (forêt AND semis) OR KEY (forêt AND gaulis) OR KEY (forêt AND sol) OR KEY (forêt AND oiseau) OR KEY (forêt AND biomasse) OR KEY (forêt AND sous-bois) OR KEY (forêt AND succession) OR KEY (forêt AND dynamique) OR KEY (forêt AND croissance) OR KEY (forêt AND insect) OR KEY (forêt AND organisme) OR KEY (Canada) OR KEY (boreal∗) OR KEY (boréal∗) OR TITLE (forest AND recovery) OR TITLE (forêt AND Régénération) OR TITLE (Forest AND Disturbance) OR TITLE (forêt AND Perturbation) OR TITLE (forest AND Biodiversity) OR TITLE (forest AND animal) OR TITLE (forest AND seedling∗) OR TITLE (forest AND sapling∗) OR TITLE (forest AND soil∗) OR TITLE (forest AND bird∗) OR TITLE (forest AND Biomass) OR TITLE (forest AND succession) OR TITLE (forest AND Understory) OR TITLE (forest AND Dynamic) OR TITLE (forest AND Growth) OR TITLE (forest AND insect) OR TITLE (forest AND organism) OR TITLE (forêt AND Biodiversité) OR TITLE (forêt AND animal) OR TITLE (forêt AND semis) OR TITLE (forêt AND gaulis) OR TITLE (forêt AND sol) OR TITLE (forêt AND oiseau) OR TITLE (forêt AND biomasse) OR TITLE (forêt AND sous-bois) OR TITLE (forêt AND succession) OR TITLE (forêt AND dynamique) OR TITLE (forêt AND croissance) OR TITLE (forêt AND insect) OR TITLE (forêt AND organisme) OR TITLE (Canada) OR TITLE (boreal∗) OR TITLE (boréal∗)) AND AFFILCOUNTRY(Canada) AND PUBYEAR IS 1998 AND SUBJAREA(AGRI)
	CFS	Q2: (TITLE (forest AND outbreak) OR TITLE (forest AND spruce budworm) OR TITLE (forest AND Montain pine beetle) OR TITLE (forest AND hemlock looper) OR TITLE (forest AND pest) OR TITLE (forêt AND dendroctone) OR TITLE (forêt AND tordeuse) OR TITLE (forêt AND dendroctone) OR TITLE (forêt AND arpenteuse de la pruche) OR TITLE (forest AND disease) OR TITLE (forêt AND maladie) OR TITLE (forêt AND peste) OR KEY (forest AND outbreak) OR KEY (forest AND spruce budworm) OR KEY (forest AND Montain pine beetle) OR KEY (forest AND hemlock looper) OR KEY (forest AND pest) OR KEY (forêt AND dendroctone) OR KEY (forêt AND tordeuse) OR KEY (forêt AND dendroctone) OR KEY (forêt AND arpenteuse

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Table A2. (*continued*).

Disturbance	Origin	Scopus query
		de la pruche) OR KEY (forest AND disease) OR KEY (forêt AND maladie) OR KEY (forêt AND peste)) AND (KEY (forest AND recovery) OR KEY (forêt AND Régénération) OR KEY (forest AND Biodiversity) OR KEY (forest AND animal) OR KEY (forest AND seedling*) OR KEY (forest AND sapling*) OR KEY (forest AND soil*) OR KEY (forest AND bird*) OR KEY (forest AND Biomass) OR KEY (forest AND succession) OR KEY (forest AND Understory) OR KEY (forest AND Dynamic) OR KEY (forest AND Growth) OR KEY (forest AND insect) OR KEY (forest AND organism) OR KEY (forêt AND Biodiversité) OR KEY (forêt AND animal) OR KEY (forêt AND semis) OR KEY (forêt AND gaulis) OR KEY (forêt AND sol) OR KEY (forêt AND oiseau) OR KEY (forêt AND biomasse) OR KEY (forêt AND sous-bois) OR KEY (forêt AND succession) OR KEY (forêt AND dynamique) OR KEY (forêt AND croissance) OR KEY (forêt AND insect) OR KEY (forêt AND organisme) OR KEY (Canada) OR KEY (boreal*) OR KEY (boréal*) OR TITLE (forest AND recovery) OR TITLE (forêt AND Régénération) OR TITLE (Forest AND Disturbance) OR TITLE (forêt AND Perturbation) OR TITLE (forest AND Biodiversity) OR TITLE (forest AND animal) OR TITLE (forest AND seedling*) OR TITLE (forest AND sapling*) OR TITLE (forest AND soil*) OR TITLE (forest AND bird*) OR TITLE (forest AND Biomass) OR TITLE (forest AND succession) OR TITLE (forest AND Understory) OR TITLE (forest AND Dynamic) OR TITLE (forest AND Growth) OR TITLE (forest AND insect) OR TITLE (forest AND organism) OR TITLE (forêt AND Biodiversité) OR TITLE (forêt AND animal) OR TITLE (forêt AND semis) OR TITLE (forêt AND gaulis) OR TITLE (forêt AND sol) OR TITLE (forêt AND oiseau) OR TITLE (forêt AND biomasse) OR TITLE (forêt AND sous-bois) OR TITLE (forêt AND succession) OR TITLE (forêt AND dynamique) OR TITLE (forêt AND croissance) OR TITLE (forêt AND insect) OR TITLE (forêt AND organisme) OR TITLE (Canada) OR TITLE (boreal*) OR TITLE (boréal*)) AND AFFILCOUNTRY(Canada) AND PUBYEAR IS 1998 AND SUBJAREA(AGRI) AND (AFFILORG(Canadian Forest Service) OR AFFILORG (CFS) OR AFFILORG (Atlantic Forestry Cent*) OR AFFILORG (AFC) OR AFFILORG (Canadian Wood Fibre Cent*) OR AFFILORG (CWFC) OR AFFILORG (Great Lakes Forestry Cent*) OR AFFILORG (GLFC) OR AFFILORG (Laurentian Forestry Cent*) OR AFFILORG (LFC) OR AFFILORG (Northern Forestry cent*) OR AFFILORG (Service Canadien des forêts) OR AFFILORG (SCF) OR AFFILORG (Centre de Foresterie de l'Atlantique) OR AFFILORG (CFA) OR AFFILORG (Centre canadien sur la fibre de bois) OR AFFILORG (CCFB) OR AFFILORG (Centre de foresterie des Grands Lacs) OR AFFILORG (CFGL) OR AFFILORG (Centre de foresterie des Laurentides) OR AFFILORG (CFL) OR AFFILORG (Centre de foresterie du Nord) OR AFFILORG (CFN) OR AFFILORG (Centre de foresterie du Pacifique) OR AFFILORG (CFP))
Mining and seismic line	Canada	Q1: (KEY (forest AND seismic line) OR KEY (forest AND spruce budworm) OR KEY (forest AND mining) OR KEY (forest AND mine) OR KEY (forêt AND ligne sismique) OR KEY (forêt AND mine) OR TITLE (forest AND seismic line) OR TITLE (forest AND mining) OR TITLE (forest AND mine) OR TITLE (forêt AND ligne sismique) OR TITLE (forêt AND mine)) AND (KEY (forest AND recovery) OR KEY (forêt AND Régénération) OR KEY (forest AND Biodiversity) OR KEY (forest AND animal) OR KEY (forest AND seedling*) OR KEY (forest AND sapling*) OR KEY (forest AND soil*) OR KEY (forest AND bird*) OR KEY (forest AND Biomass) OR KEY (forest AND succession) OR KEY (forest AND Understory) OR KEY (forest AND Dynamic) OR KEY (forest AND Growth) OR KEY (forest AND insect) OR KEY (forest AND organism) OR KEY (forêt AND Biodiversité) OR KEY (forêt AND animal) OR KEY (forêt AND semis) OR KEY (forêt AND gaulis) OR KEY (forêt AND sol) OR KEY (forêt AND oiseau) OR KEY (forêt AND biomasse) OR KEY (forêt AND sous-bois) OR KEY (forêt AND succession) OR KEY (forêt AND dynamique) OR KEY (forêt AND croissance) OR KEY (forêt AND insect) OR KEY (forêt AND organisme) OR KEY (Canada) OR KEY (boreal*) OR KEY (boréal*) OR TITLE (forest AND recovery) OR TITLE (forêt AND Régénération) OR TITLE (Forest AND Disturbance) OR TITLE (forêt AND Perturbation) OR TITLE (forest AND Biodiversity) OR TITLE (forest AND animal) OR TITLE (forest AND seedling*) OR TITLE (forest AND sapling*) OR TITLE (forest AND soil*) OR TITLE (forest AND bird*) OR TITLE (forest AND Biomass) OR TITLE (forest AND succession) OR TITLE (forest AND Understory) OR TITLE (forest AND Dynamic) OR TITLE (forest AND Growth) OR TITLE (forest AND insect) OR TITLE (forest AND organism) OR TITLE (forêt AND Biodiversité) OR TITLE (forêt AND animal) OR TITLE (forêt AND semis) OR TITLE (forêt AND gaulis) OR TITLE (forêt AND sol) OR TITLE (forêt AND oiseau) OR TITLE (forêt AND biomasse) OR TITLE (forêt AND sous-bois) OR TITLE (forêt AND succession) OR TITLE (forêt AND dynamique) OR TITLE (forêt AND croissance) OR TITLE (forêt AND insect) OR TITLE (forêt AND organisme) OR TITLE (Canada) OR TITLE (boreal*) OR TITLE (boréal*)) AND AFFILCOUNTRY(Canada) AND PUBYEAR IS 1998 AND SUBJAREA(AGRI)
	CFS	Q2: (KEY (forest AND seismic line) OR KEY (forest AND spruce budworm) OR KEY (forest AND mining) OR KEY (forest AND mine) OR KEY (forêt AND ligne sismique) OR KEY (forêt AND mine) OR TITLE (forest AND seismic line) OR TITLE (forest AND mining) OR TITLE (forest AND mine) OR TITLE (forêt AND ligne sismique) OR TITLE (forêt AND mine)) AND (KEY (forest AND recovery) OR KEY (forêt AND Régénération) OR KEY (forest AND Biodiversity) OR KEY (forest AND animal) OR KEY (forest AND seedling*) OR KEY (forest AND sapling*) OR KEY (forest AND soil*) OR KEY (forest AND bird*) OR KEY (forest AND Biomass) OR KEY (forest AND succession) OR KEY (forest AND Understory) OR KEY (forest AND Dynamic) OR KEY (forest AND Growth) OR KEY (forest AND insect) OR KEY (forest AND organism) OR KEY (forêt AND Biodiversité) OR KEY (forêt AND animal) OR KEY (forêt AND semis) OR KEY (forêt AND gaulis) OR KEY (forêt AND sol) OR KEY (forêt AND oiseau) OR KEY (forêt AND biomasse) OR KEY (forêt AND sous-bois) OR KEY (forêt AND succession) OR KEY (forêt AND dynamique) OR KEY (forêt AND croissance) OR KEY (forêt AND insect) OR KEY (forêt AND organisme) OR KEY (Canada) OR KEY (boreal*) OR KEY (boréal*) OR TITLE (forest AND recovery) OR TITLE (forêt AND Régénération) OR TITLE (Forest AND Disturbance) OR TITLE (forêt AND Perturbation) OR TITLE (forest AND Biodiversity) OR TITLE (forest AND animal) OR TITLE (forest AND seedling*) OR TITLE (forest AND sapling*) OR TITLE (forest AND soil*) OR TITLE (forest AND bird*) OR TITLE (forest AND Biomass) OR TITLE (forest AND succession) OR TITLE (forest AND Understory) OR TITLE (forest AND Dynamic) OR TITLE (forest AND Growth) OR TITLE (forest AND insect) OR TITLE (forest AND organism) OR TITLE (forêt AND Biodiversité) OR TITLE (forêt AND animal) OR TITLE (forêt AND semis) OR TITLE (forêt AND gaulis) OR TITLE (forêt AND sol) OR TITLE (forêt AND oiseau) OR TITLE (forêt AND biomasse) OR TITLE (forêt AND sous-bois) OR TITLE (forêt AND succession) OR TITLE (forêt AND dynamique) OR TITLE

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Table A2. (*concluded*).

Disturbance	Origin	Scopus query
		(forêt AND croissance) OR TITLE (forêt AND insect) OR TITLE (forêt AND organisme) OR TITLE (Canada) OR TITLE (boreal∗) OR TITLE (boréal∗)) AND AFFILCOUNTRY(Canada) AND PUBYEAR IS 1998 AND SUBJAREA(AGRI) AND (AFFILORG(Canadian Forest Service) OR AFFILORG (CFS) OR AFFILORG (Atlantic Forestry Cent∗) OR AFFILORG (AFC) OR AFFILORG (Canadian Wood Fibre Cent∗) OR AFFILORG (CWFC) OR AFFILORG (Great Lakes Forestry Cent∗) OR AFFILORG (GLFC) OR AFFILORG (Laurentian Forestry Cent∗) OR AFFILORG (LFC) OR AFFILORG (Northern Forestry cent∗) OR AFFILORG (Service Canadien des forêts) OR AFFILORG (SCF) OR AFFILORG (Centre de Foresterie de l'Atlantique) OR AFFILORG (CFA) OR AFFILORG (Centre canadien sur la fibre de bois) OR AFFILORG (CCFB) OR AFFILORG (Centre de foresterie des Grands Lacs) OR AFFILORG (CFGL) OR AFFILORG (Centre de foresterie des Laurentides) OR AFFILORG (CFL) OR AFFILORG (Centre de foresterie du Nord) OR AFFILORG (CFN) OR AFFILORG (Centre de foresterie du Pacifique) OR AFFILORG (CFP))
Other abiotic disturbances	Canada	Q1: (KEY (forest AND windthrow) OR KEY (forest AND drougth) OR KEY (forest AND hurricane) OR KEY (forest AND flood) OR KEY (forêt AND chablis) OR KEY (forêt AND secheresse) OR KEY (forêt AND ouragan) OR KEY (forêt AND inondation) OR TITLE (forest AND windthrow) OR TITLE (forest AND drougth) OR TITLE (forest AND hurricane) OR TITLE (forest AND flood) OR TITLE (forêt AND chablis) OR TITLE (forêt AND secheresse) OR TITLE (forêt AND ouragan) OR TITLE (forêt AND inondation)) AND (KEY (forest AND recovery) OR KEY (forêt AND Régénération) OR KEY (forest AND Biodiversity) OR KEY (forest AND animal) OR KEY (forest AND seedling∗) OR KEY (forest AND sapling∗) OR KEY (forest AND soil∗) OR KEY (forest AND bird∗) OR KEY (forest AND Biomass) OR KEY (forest AND succession) OR KEY (forest AND Understory) OR KEY (forest AND Dynamic) OR KEY (forest AND Growth) OR KEY (forest AND insect) OR KEY (forest AND organism) OR KEY (forêt AND Biodiversité) OR KEY (forêt AND animal) OR KEY (forêt AND semis) OR KEY (forêt AND gaulis) OR KEY (forêt AND sol) OR KEY (forêt AND oiseau) OR KEY (forêt AND biomasse) OR KEY (forêt AND sous-bois) OR KEY (forêt AND succession) OR KEY (forêt AND dynamique) OR KEY (forêt AND croissance) OR KEY (forêt AND insect) OR KEY (forêt AND organisme) OR KEY (Canada) OR KEY (boreal∗) OR KEY (boréal∗) OR TITLE (forest AND recovery) OR TITLE (forêt AND Régénération) OR TITLE (Forest AND Disturbance) OR TITLE (forêt AND Perturbation) OR TITLE (forest AND Biodiversity) OR TITLE (forest AND animal) OR TITLE (forest AND seedling∗) OR TITLE (forest AND sapling∗) OR TITLE (forest AND soil∗) OR TITLE (forest AND bird∗) OR TITLE (forest AND Biomass) OR TITLE (forest AND succession) OR TITLE (forest AND Understory) OR TITLE (forest AND Dynamic) OR TITLE (forest AND Growth) OR TITLE (forest AND insect) OR TITLE (forest AND organism) OR TITLE (forêt AND Biodiversité) OR TITLE (forêt AND animal) OR TITLE (forêt AND semis) OR TITLE (forêt AND gaulis) OR TITLE (forêt AND sol) OR TITLE (forêt AND oiseau) OR TITLE (forêt AND biomasse) OR TITLE (forêt AND sous-bois) OR TITLE (forêt AND succession) OR TITLE (forêt AND dynamique) OR TITLE (forêt AND croissance) OR TITLE (forêt AND insect) OR TITLE (forêt AND organisme) OR TITLE (Canada) OR TITLE (boreal∗) OR TITLE (boréal∗)) AND AFFILCOUNTRY(Canada) AND PUBYEAR IS 1998 AND SUBJAREA(AGRI)
	CFS	Q2: (KEY (forest AND windthrow) OR KEY (forest AND drougth) OR KEY (forest AND hurricane) OR KEY (forest AND flood) OR KEY (forêt AND chablis) OR KEY (forêt AND secheresse) OR KEY (forêt AND ouragan) OR KEY (forêt AND inondation) OR TITLE (forest AND windthrow) OR TITLE (forest AND drougth) OR TITLE (forest AND hurricane) OR TITLE (forest AND flood) OR TITLE (forêt AND chablis) OR TITLE (forêt AND secheresse) OR TITLE (forêt AND ouragan) OR TITLE (forêt AND inondation)) AND (KEY (forest AND recovery) OR KEY (forêt AND Régénération) OR KEY (forest AND Biodiversity) OR KEY (forest AND animal) OR KEY (forest AND seedling∗) OR KEY (forest AND sapling∗) OR KEY (forest AND soil∗) OR KEY (forest AND bird∗) OR KEY (forest AND Biomass) OR KEY (forest AND succession) OR KEY (forest AND Understory) OR KEY (forest AND Dynamic) OR KEY (forest AND Growth) OR KEY (forest AND insect) OR KEY (forest AND organism) OR KEY (forêt AND Biodiversité) OR KEY (forêt AND animal) OR KEY (forêt AND semis) OR KEY (forêt AND gaulis) OR KEY (forêt AND sol) OR KEY (forêt AND oiseau) OR KEY (forêt AND biomasse) OR KEY (forêt AND sous-bois) OR KEY (forêt AND succession) OR KEY (forêt AND dynamique) OR KEY (forêt AND croissance) OR KEY (forêt AND insect) OR KEY (forêt AND organisme) OR KEY (Canada) OR KEY (boreal∗) OR KEY (boréal∗) OR TITLE (forest AND recovery) OR TITLE (forêt AND Régénération) OR TITLE (Forest AND Disturbance) OR TITLE (forêt AND Perturbation) OR TITLE (forest AND Biodiversity) OR TITLE (forest AND animal) OR TITLE (forest AND seedling∗) OR TITLE (forest AND sapling∗) OR TITLE (forest AND soil∗) OR TITLE (forest AND bird∗) OR TITLE (forest AND Biomass) OR TITLE (forest AND succession) OR TITLE (forest AND Understory) OR TITLE (forest AND Dynamic) OR TITLE (forest AND Growth) OR TITLE (forest AND insect) OR TITLE (forest AND organism) OR TITLE (forêt AND Biodiversité) OR TITLE (forêt AND animal) OR TITLE (forêt AND semis) OR TITLE (forêt AND gaulis) OR TITLE (forêt AND sol) OR TITLE (forêt AND oiseau) OR TITLE (forêt AND biomasse) OR TITLE (forêt AND sous-bois) OR TITLE (forêt AND succession) OR TITLE (forêt AND dynamique) OR TITLE (forêt AND croissance) OR TITLE (forêt AND insect) OR TITLE (forêt AND organisme) OR TITLE (Canada) OR TITLE (boreal∗) OR TITLE (boréal∗)) AND AFFILCOUNTRY(Canada) AND PUBYEAR IS 1998 AND SUBJAREA(AGRI) AND (AFFILORG(Canadian Forest Service) OR AFFILORG (CFS) OR AFFILORG (Atlantic Forestry Cent∗) OR AFFILORG (AFC) OR AFFILORG (Canadian Wood Fibre Cent∗) OR AFFILORG (CWFC) OR AFFILORG (Great Lakes Forestry Cent∗) OR AFFILORG (GLFC) OR AFFILORG (Laurentian Forestry Cent∗) OR AFFILORG (LFC) OR AFFILORG (Northern Forestry cent∗) OR AFFILORG (Service Canadien des forêts) OR AFFILORG (SCF) OR AFFILORG (Centre de Foresterie de l'Atlantique) OR AFFILORG (CFA) OR AFFILORG (Centre canadien sur la fibre de bois) OR AFFILORG (CCFB) OR AFFILORG (Centre de foresterie des Grands Lacs) OR AFFILORG (CFGL) OR AFFILORG (Centre de foresterie des Laurentides) OR AFFILORG (CFL) OR AFFILORG (Centre de foresterie du Nord) OR AFFILORG (CFN) OR AFFILORG (Centre de foresterie du Pacifique) OR AFFILORG (CFP))

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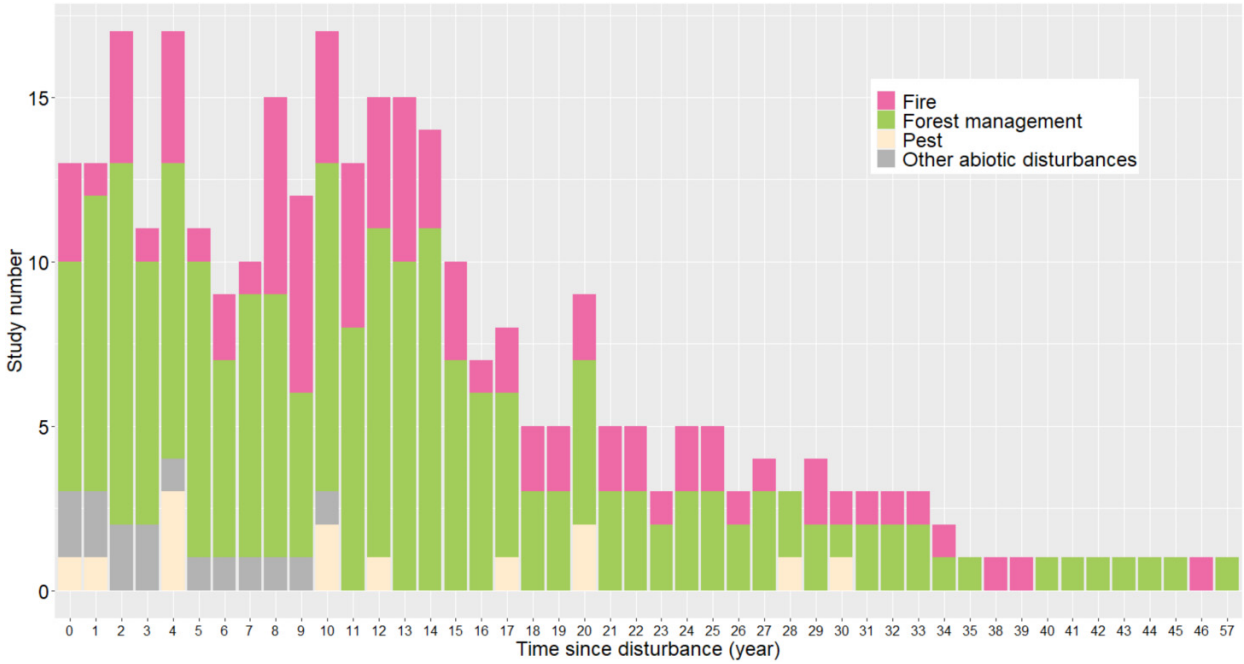
Fig. A1. CFS post-fire, forest management, pest, and other abiotic disturbances studies according to the time (years) since the disturbance.



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