# Exploring Adverse Health Outcomes among Canadian Forestry Workers and Respiratory Hazard Management Practices by Wildfire Agencies both Domestically and Abroad

Sydney Guerrero, BSc, MSc Candidate
Supervisors: Dr. Fatih Sekercioglu, Dr. Thomas Tenkate
School of Occupational and Public Health
MSc Thesis Oral Defence Examination

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# Agenda

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# Chapter 1 - Introduction

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# Research Context

**Climate change has impacted wildfire activity, increasing the magnitude of respiratory hazards.**

- The effects of **climate change** on wildfire activity and behaviour, impact wildland firefighter (WFF) risk of exposure to occupational hazards (Sullivan et al., 2022; Pausas & Keeley, 2021; Running, 2006).
- **Respiratory hazards** are exacerbated by the effects of climate change and are inhalable substances prevalent in all acts of management (Demers et al., 2022; Navarro, 2020; Austin, 2008).
- Exposure to respiratory hazards can have **adverse outcomes** (OSHA, 2012; Broyles, 2013).
- Unprecedented wildfire conditions are outdating current **respiratory control practices**.

**Figure 1.** Donnie Creek wildfire in British Columbia (BC Wildfire Service, n.d.).

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# Research Aims

1. Examine and describe trends in accepted lost-time claims (LTCs) and fatalities of silviculture and forestry workers in Canada from 2013-2022.
2. Understand and compare Canadian wildland fire management agencies' respiratory control measure documents to provide recommendations for agency improvement.
3. Understand and compare international wildland fire management agencies' respiratory personal protective equipment (PPE) documents' content.

**Figure 2.** Parks Canada WFFs conducting mop-up operations at Jasper National Park in Alberta following 2024 summer wildfire (Parks Canada, 2024).

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# Research Significance

**WFFs are at the forefront of natural disasters and have unique and evolving health and safety needs.**

- Respiratory hazards are a primary concern due to:
  - **Prevalence** (NIEHS, 2024);
  - Potential **long-term health effects** (Health Canada, 2020);
  - **Safety implications** (Broyles, 2013); and
  - **Lack of control measures** (Navarro, 2020)
- **WFF-specific** research can better inform occupational health and safety policies and procedures.
  - Existing occupational exposure limits (OELs) are based on urban conditions (Navarro, 2022; Navarro, 2020).
- Support the development of enhanced respiratory control policies/procedures to mitigate adverse outcomes.

**Figure 3.** Prescribed burn in Kamloops, British Columbia initiated by BC Wildfire Service in July of 2023 (Winter, 2023).

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# Chapter 2 - Literature Review

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# Review Themes

| | |
|---|---|
| 1 | Wildland Fire Ecology |
| 2 | Climate Change on Wildfires |
| 3 | Wildland Urban Interface (WUI) Fires |
| 4 | Canadian Wildland Firefighter Roles and Responsibilities |
| 5 | Wildland Fire Management Strategies |
| 6 | Wildland Fire Respiratory Hazards |
| 7 | Wildland Fire Respiratory Hazard Control Measures |


**Figure 6.** BC Wildfire Service WFF personal protective equipment (PPE) (Nelms, 2023).

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# Review Findings

**Key factors influencing WFF respiratory hazard exposure include the environment, management activities, and PPE.**

- WFFs are not equipped for WUI fires (CDC& NIOSH, 2019).
  - Structural firefighters (SFFs) are issued **self-contained breathing apparatuses (SCBAs),** not feasible for WFFs.
- **Management strategies** dictate WFF exposure (Navarro, 2020).
  - Fire and non-fire activities
- No mask meets the **National Fire Protection Association (NFPA) 1984 standard** (Navarro, 2020).
  - Gas and particulate filtration (e.g., CO, VOCs, $PM_{2.5}$).
  - Flame retardant


**Figure 8.** Different types of respiratory PPE (Forestry Suppliers, n.d.; Dräger, n.d.).

# Research Gaps

**Future research should investigate long-term health effects, differences in exposure, levels of administrative controls and their application in the workplace.**

- **Longitudinal cohort studies** tracking chronic respiratory effects.
  - Across multiple wildfire seasons to capture years of repeated exposure.
- **Comparative exposure assessment** of respiratory hazards between WFF crew types.
  - Crew methods and tools used for management.
- **Evaluations** of respiratory control measures.
  - Determine effectiveness (i.e., engineering, administrative, and PPE).
- **Examinations** of agency respiratory control measure policies.
  - Determine content and alignment with standards.
  - Investigate agency application of among leadership, mid-level management and workers.

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# Chapter 3 - Aim 1: Descriptive Analysis of Silviculture and Forestry Workers Accepted LTCs and Fatalities between 2013-2022 in Canada

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# Research Methods

**Study Design**

Retrospective **descriptive analysis** of secondary data from 2013-2022.

**Dataset**

**Accepted lost-time claims (LTCs) and fatality cases** of Canadian silviculture and forestry workers obtained from the Association of Workers' Compensation Board of Canada (AWCBC).

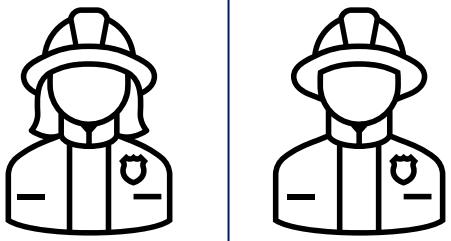
AWCBC ACATC

(AWCBC, n.d.)

**Case Demographics**

Males accounted for the **majority** of cases.

**12.7%** **87.3%**



**65.6%** of worker cases were aged 39 years or younger, with **'25-29 years'** reporting the most cases.

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# Study Findings

**Accepted lost time claims have increased by 32% from 2013 to 2022.**

- Cases from 2013 to 2022:
  - Accepted Fatalities: **6**
  - Accepted LTCs: **2086**
- Case Characteristics:
  - Source of Injury/Disease: **Persons, Plants, Animals, and Minerals** (~980)
  - Nature of Injury/Disease: **Traumatic Injuries and Disorders** (1812)
  - Event/Exposure: **Overexertion and Bodily Reaction** (~810)
  - Affected Body Part: **Lower Extremities** (620)

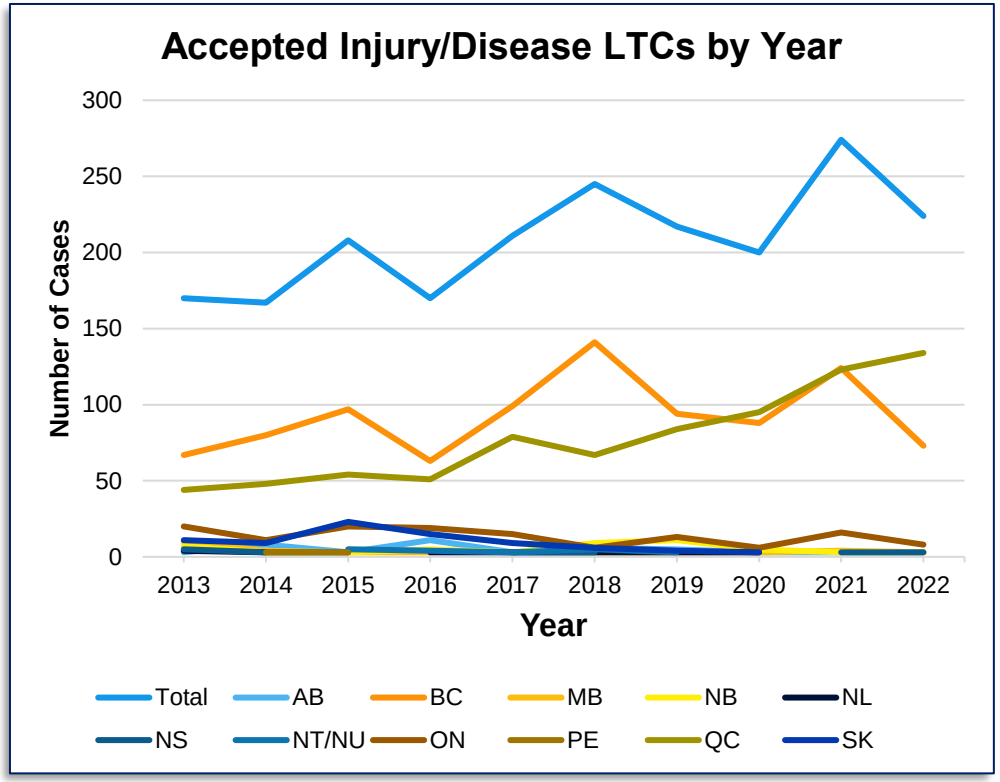


**Figure 9.** Multivariate line graph of accepted LTCs by province and territory from 2013-2022.

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# Chapter 4 -Aim 2: Cross-Jurisdictional Case Study of Canadian Wildland Fire Management Agency Respiratory Control Measure Documents

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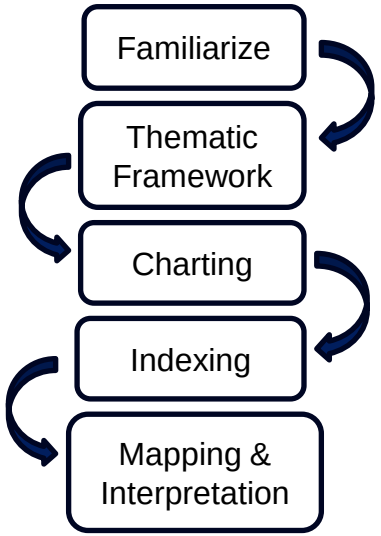
# Research Methods

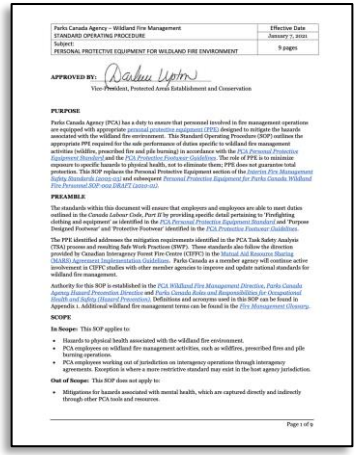
## Study Design

Cross-jurisdictional case study, using the **framework analysis** method (Ritchie & Spencer, 1994).




## Data

Canadian federal, provincial, and territorial wildland fire management agency respiratory hazard control-related **documents.**



Parks Canada Agency – Wildland Fire Management | Effective Date: January 7, 2021
STANDARD OPERATING PROCEDURE
Subject:
PERSONAL PROTECTIVE EQUIPMENT FOR WILDLAND FIRE ENVIRONMENT | 9 pages

APPROVED BY:
Vice-President, Protected Areas Establishment and Conservation

PURPOSE

PREAMBLE

SCOPE

In Scope: This SOP applies to:

- Hazards to physical health associated with the wildland fire environment.
- PCA employees on wildland fire management activities, such as wildfires, prescribed fires and pile burning operations.
- PCA employees working out of jurisdiction on interagency operations through interagency agreements. Exception is where a more restrictive standard may exist in the host agency jurisdiction.

Out of Scope: This SOP does not apply to:

- Mitigations for hazards associated with mental health, which are captured directly and indirectly through other PCA tools and resources.

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## Case Demographics

Federal: 1

Provincial: 5

Territorial: 1


(Provinces and Territories of Canada, n.d.)

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# Research Methods

★ Sample Agency Documents

# Study Findings

**Agency documents do not provide substantial information addressing respiratory care.**

- 4 of 7 agencies **explicitly** addressed respiratory control measures.
  - Brief sections
  - Some control practices are not explicitly stated in written documents.
- **Administrative** and **PPE** measures are the primary modes of control.
  - Use of respiratory PPE is often at the discretion of individual WFFs.
- Areas of deficiency:
  - Factors Impacting Exposure
  - Risk Assessment

**Figure 10.** Personnel extinguishing hot spots at McKay Creek, in British Columbia, following 2021 wildfire (BC Wildfire Service, 2021).

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# Chapter 5 - Aim 3: International Case Study of Wildland Fire Management Agency Respiratory Personal Protective Equipment Documents

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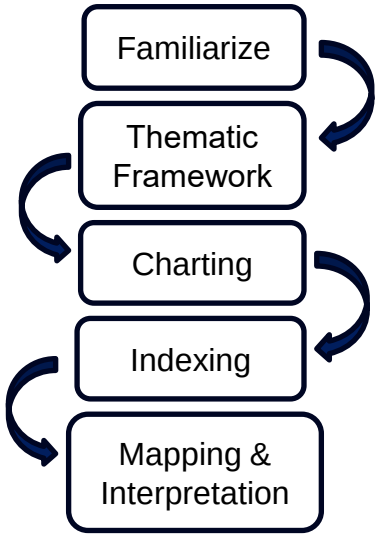
# Research Methods

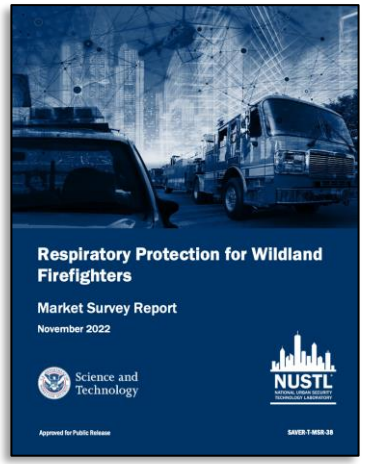
## Study Design

Case study of textual data, following the **framework analysis** method (Ritchie & Spencer, 1994).




## Data

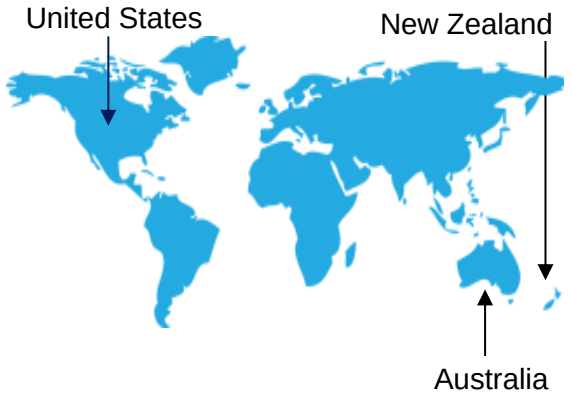
International wildland fire respiratory PPE-related **documents.**




## Case Demographics

North America: 1

Oceania: 2




(Visaenvoy, n.d.)

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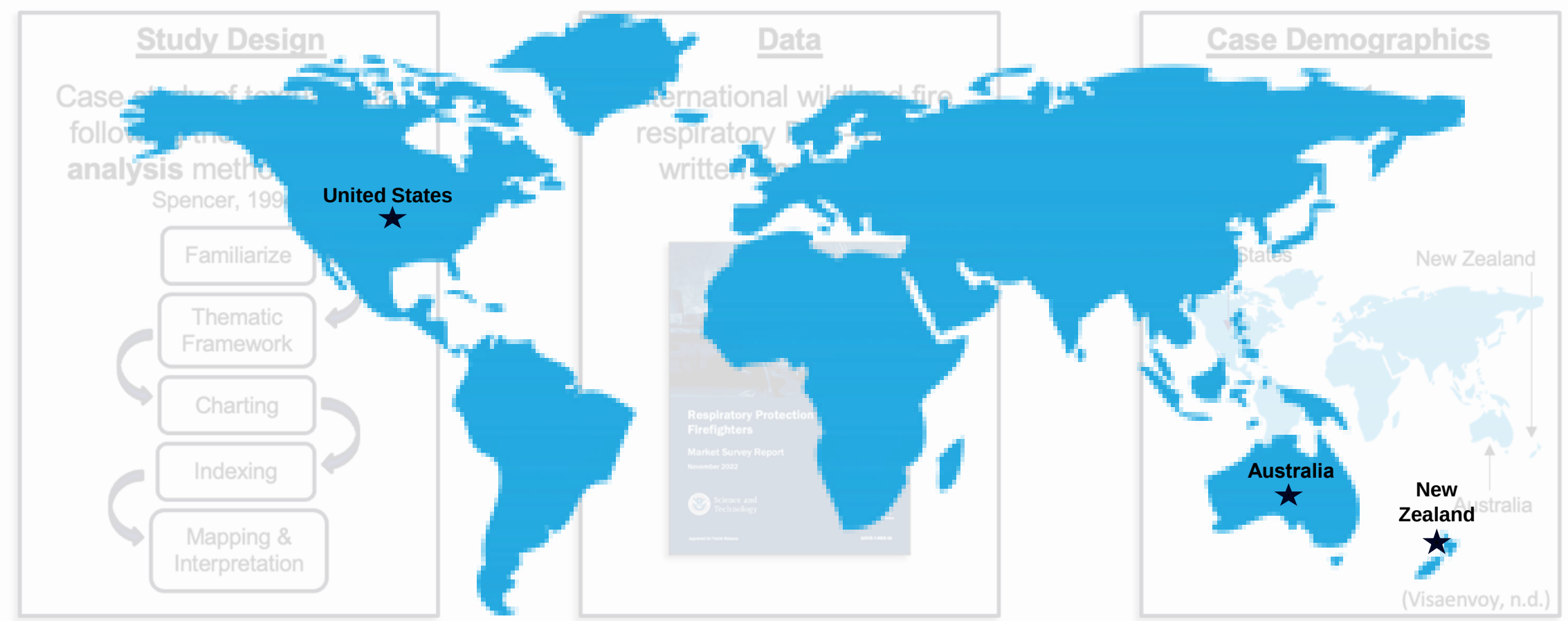
# Research Methods




★ Sample Agency Documents

# Study Findings

**Oceanic agencies' documents support a comprehensive assessment of wildfire conditions to inform respiratory PPE selection.**

**Table 1.** Select elements of the international respiratory PPE document thematic framework.

| Resp. PPE Framework | Australia | New Zealand | United States |
|---|---|---|---|
| Hazard Profile | ✓ | ✓ | ✓ |
| Risk Assessment | ✓ | ✓ | ✓ |
| PPE Specifications | ✓ | ✗ | ✓ |
| Training | ✓ | ✓ | N/A |
| Accountability | ✓ | ✓ | N/A |

✗ Unspecified ✓ Specified

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# Chapter 6 - Discussion

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# Key Takeaways

**Respiratory hazards threaten WFF health and safety; however, current control efforts are inadequate due to a lack of requirements and ineffectual PPE.**

- LTCs among forestry workers are gradually **increasing.**
- **Administrative** measures and **PPE** are the primary actions taken to control respiratory hazard exposure.
  - PPE has limited capabilities.
- Emphasis on **personal** and **collective** responsibility at the worker level.
  - Training does not reflect the high level of knowledge required.
- **No mandatory requirements** for mask use.


**Figure 11.** Ontario Ministry of Natural Resources WFFs extinguishing fire, 2024 (Freedman, 2024).

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# Recommendations

**Additional training of WFFs and collaboration with climate change stakeholders is necessary to enhance respiratory care practices.**

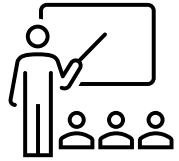
**Multidisciplinary Collaboration**

Collaboration between wildfire management agencies and **climate change researchers** to anticipate hazards and proactively implement control measures.

**Technology**

Drones:

- Initial attack (i.e., fire extinguishment)
- Reconnaissance operations (i.e., observations and monitoring)



**Revise Training**

- Climate-specific resources
- WUI crossover
- Guidance for WFFs on mask discretion
- Recognition of signs and symptoms in oneself and colleagues

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# Future Directions

**WFF-specific research is needed to enhance respiratory health outcome findings.**

- Analyze adverse health outcomes to **confirm** findings.
  - Demonstrates the need for WFF-specific data repository.
- Evaluate **factors influencing** exposure.
  - Shifting workplace conditions (i.e., WUI)
  - Crew tasks
- Evaluate the **effectiveness** of control measures.
- Investigate **worker experience** on respiratory control measures, training and enforcement.


**Figure 13.** BC Wildfire Service personnel wearing N95 respirator, 2024 (BC Wildfire Service, 2024).

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# Chapter 7 - Conclusions

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# Research Conclusions

**Existing policies need to be strengthened to mitigate adverse respiratory outcomes among WFFs.**

**Figure 14.** WFF conducting prescribed burn in Northern British Columbia (Winter, 2023).

1. Wildfire agency documents, **do not adequately** address respiratory care.
2. Policies are **suggestive** rather than prescriptive.
3. **Inconsistency** exist due to varying jurisdictional requirements, and a lack of PPE meeting NFPA standards.

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- YK Wildland Fire Management (Linda Brand)

International Agencies

- New Zealand Fire Service
- National Urban Security Technology Laboratory (US)
- Australasian Fire and Emergency Service Council


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# References


1. Alberta Wildfire. (2024). *An Alberta Wildfire helitack crew prepares to deploy.* [Photograph]. https://www.cbc.ca/news/canada/edmonton/what-you-need-to-know-to-stay-up-to-date-on-alberta-wildfires-1.7185595

2. Association of Workers' Compensation Boards of Canada. (n.d.). [Logo]. https://awcbc.org/en/

3. Austin, C. C. (2008). *Wildland firefighter health risks and respiratory protections: Risques pour la santé des pompiers forestiers et protection respiratoire*. IRSST: Institut de recherche Robert-Sauvé en santé et en sécurité du travail.

4. BC Wildfire Service. (2024). The B.C. Wildfire Service will offer a selection of masks and respiratory devices to its firefighters for the first time this year, as it prepares for a smoky fire season. [Photograph]. https://www.cbc.ca/news/canada/british-columbia/respirators-wildland-firefighters-health-1.7168504

5. BC Wildfire Service. (2021). *Firefighters with the B.C. Wildfire Service put out hot spots on the McKay Creek wildfire north of Lillooet in 2021.* [Photograph]. https://www.cbc.ca/news/canada/wildfire-fighters-smoke-protection-1.6897879

6. BC Wildfire Service. (n.d.). The Donnie Creek wildfire burns in an area between Fort Nelson and Fort St. John, B.C. in this undated handout photo provided by the BC Wildfire Service. [Photograph]. https://montreal.ctvnews.ca/forest-fire-centre-declares-2023-already-worst-year-ever-for-canadian-wildfires-1.6456879

7. Broyles, G. A. (2013). Wildland firefighter smoke exposure study.

8. Demers, P. A., DeMarini, D. M., Fent, K. W., Glass, D. C., Hansen, J., Adetona, O., ... & Schubauer-Berigan, M. K. (2022). Carcinogenicity of occupational exposure as a firefighter. *The Lancet Oncology*, *23*(8), 985-986. https://doi.org/10.1016/S1470-2045(22)00390-4

9. Dräger. (n.d.). *Selection of respiratory protection for bushfires* [Photograph]. https://www.draeger.com/en_aunz/Safety/Respiratory-Protective-Equipment/Bushfire-Kits


Toronto Metropolitan University

# References


10. Forestry Suppliers. (n.d.). *Bandit Scarf*. Forestry Suppliers, Inc. Retrieved July 16, 2024, from https://www.forestry-suppliers.com/p/23671/15291/bandit-scarf

11. Freedman, N. (2024). [Photograph]. https://www.baytoday.ca/local-news/ontario-spending-5-million-to-attract-firefighters-8491690

12. Health Canada. (2020, September 28). *Guidance for Cleaner Air Spaces during Wildfire Smoke Events.* https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidance-cleaner-air-spaces-during-wildfire-smoke-events.html

13. Mine Safety Appliances. (n.d.). Firefighter SCBA buying guide. Retrieved July 16, 2024, from https://ca.msasafety.com/safetyguides?locale=fr

14. National Institute of Environmental Health Sciences. (2024, July 12). *Air Pollution and Your Health*. https://www.niehs.nih.gov/health/topics/agents/air-pollution

15. Navarro, K. M., Butler, C. R., Fent, K., Toennis, C., Sammons, D., Ramirez-Cardenas, A., ... & Domitrovich, J. W. (2022). The wildland firefighter exposure and health effect (WFFEHE) study: Rationale, design, and methods of a repeated-measures study. *Annals of work exposures and health*, *66*(6), 714-727. https://doi.org/10.1093/annweh/wxab117

16. Navarro, K. (2020). Working in Smoke: Wildfire Impacts on the Health of Firefighters and Outdoor Workers and Mitigation Strategies. *Clinics in Chest Medicine*, *41*(4), 763–769. https://doi.org/10.1016/j.ccm.2020.08.017

17. Nelms, B. (2023). A recruit works to contain and put out a fire near Merritt, B.C., during a training exercise. Though hard hats and other gear are standard for wildfire fighters, respiratory protection is not. [Photograph]. https://www.cbc.ca/news/canada/wildfire-fighters-smoke-protection-1.6897879

18. Occupational Safety and Health Administration. (2012, January). *Transcript for the OSHA Training Video Entitled Respiratory Protection in General Industry: An Overview of Hazards & OSHA's Program Requirements*. https://www.osha.gov/video/respiratory-protection/general-industry/transcript

19. Parks Canada. (2024). Wildfire status—Jasper Wildfire Complex [Photograph]. https://parks.canada.ca/pn-np/ab/jasper/visit/feu-alert-fire/feudeforet-wildfire


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# References


20. Parks Canada. (2020). The #ParksCanada fire crew in #Oregon is nearing the end of their two-week deployment and will be flying back to today and tomorrow. We'll be happy to welcome them home after all their hard work! #thankyoufirefighters #thankyoufirstresponders [Photograph]. https://x.com/ParksCanada/status/1312022137193017346

21. Pausas, J. G., & Keeley, J. E. (2021). Wildfires and global change. *Frontiers in Ecology and the Environment*, *19*(7), 387–395. https://doi.org/10.1002/fee.2359

22. Provinces and territories of Canada. (n.d.). [Map]. https://en.wikipedia.org/wiki/Provinces_and_territories_of_Canada

23. Running, S. W. (2006). Is Global Warming Causing More, Larger Wildfires? *Science*, *313*(5789), 927–928. https://doi.org/10.1126/science.1130370

24. Sullivan, A., Baker, E., Kurvits, T., Popescu, A., Paulson, A. K., Cardinal Christianson, A., ... & Reisen, F. (2022). Spreading like wildfire: The rising threat of extraordinary landscape fires.

25. visaenvoy. (n.d.). *Global Mobility Services* [Map]. https://visaenvoy.com/global-mobility-services/

26. Winter, J. (2023). A member of the B.C. Wildfire Service watches a planned ignition on the Ross Moore Lake fire in Kamloops, British Columbia, Canada, in July. [Photograph]. https://www.axios.com/2023/08/14/canada-wildfires-fall-fire-activity-threat

27. Winter, J. (2023). A firefighter uses a drip torch to set a planned ignition on a wildfire burning near a highway outside Vanderhoof, in northern B.C., in July. Nearly every province and territory has different rules on compensation for wildland firefighters who become ill because of their job. [Photograph]. https://www.cbc.ca/news/canada/wildland-firefighters-compensation-canada-1.6974808

28. Navarro, K. M., Butler, C. R., Fent, K., Toennis, C., Sammons, D., Ramirez-Cardenas, A., ... & Domitrovich, J. W. (2022). The wildland firefighter exposure and health effect (WFFEHE) study: Rationale, design, and methods of a repeated-measures study. *Annals of work exposures and health*, *66*(6), 714-727. https://doi.org/10.1093/annweh/wxab117


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# References


29. Navarro, K. (2020). Working in Smoke: Wildfire Impacts on the Health of Firefighters and Outdoor Workers and Mitigation Strategies. *Clinics in Chest Medicine*, *41*(4), 763–769. https://doi.org/10.1016/j.ccm.2020.08.017

30. Nelms, B. (2023). A recruit works to contain and put out a fire near Merritt, B.C., during a training exercise. Though hard hats and other gear are standard for wildfire fighters, respiratory protection is not. [Photograph]. https://www.cbc.ca/news/canada/wildfire-fighters-smoke-protection-1.6897879

31. Occupational Safety and Health Administration. (2012, January). *Transcript for the OSHA Training Video Entitled Respiratory Protection in General Industry: An Overview of Hazards & OSHA's Program Requirements*. https://www.osha.gov/video/respiratory-protection/general-industry/transcript

32. Parks Canada. (2024). Wildfire status—Jasper Wildfire Complex [Photograph]. https://parks.canada.ca/pn-np/ab/jasper/visit/feu-alert-fire/feudeforet-wildfire

33. Parks Canada. (2020). The #ParksCanada fire crew in #Oregon is nearing the end of their two-week deployment, and will be flying back to today and tomorrow. We'll be happy to welcome them home after all their hard work! #thankyoufirefighters #thankyoufirstresponders [Photograph]. https://x.com/ParksCanada/status/1312022137193017346

34. Pausas, J. G., & Keeley, J. E. (2021). Wildfires and global change. *Frontiers in Ecology and the Environment*, *19*(7), 387–395. https://doi.org/10.1002/fee.2359

35. Provinces and territories of Canada. (n.d.). [Map]. https://en.wikipedia.org/wiki/Provinces_and_territories_of_Canada

36. Running, S. W. (2006). Is Global Warming Causing More, Larger Wildfires? *Science*, *313*(5789), 927–928. https://doi.org/10.1126/science.1130370

37. Sullivan, A., Baker, E., Kurvits, T., Popescu, A., Paulson, A. K., Cardinal Christianson, A., ... & Reisen, F. (2022). Spreading like wildfire: The rising threat of extraordinary landscape fires.

38. Smith, K. (July 24, 2024). A building burns in the Jasper townsite on Wednesday (July 24) during the Jasper wildfire. [Photograph}. https://edmontonsun.com/opinion/columnists/gunter-jasper-blaze-exposes-possible-flaws-in-parks-canada-wildfire-strategy


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# References


39. Winter, J. (2023). A member of the B.C. Wildfire Service watches a planned ignition on the Ross Moore Lake fire in Kamloops, British Columbia, Canada, in July. [Photograph]. https://www.axios.com/2023/08/14/canada-wildfires-fall-fire-activity-threat

40. Winter, J. (2023). A firefighter uses a drip torch to set a planned ignition on a wildfire burning near a highway outside Vanderhoof, in northern B.C., in July. Nearly every province and territory has different rules on compensation for wildland firefighters who become ill because of their job. [Photograph]. https://www.cbc.ca/news/canada/wildland-firefighters-compensation-canada-1.6974808


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