POWELL RIVER REGIONAL DISTRICT
Community Wildfire Protection Plan

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Registered Professional Foresters
Signature and Seal

ACKNOWLEDGEMENTS

B.A. Blackwell & Associates Ltd. would like to extend our thanks to the staff of the Powell River Regional District, staff of the City of Powell River, Tla'amin First Nation, Northside, Malaspina and Tla'amin Fire Departments, and the Ministry of Forests, Lands and Natural Resource Operations, Powell River Wildfire Management Base for their kind assistance and guidance in the completion of this Community Wildfire Protection Plan.

EXECUTIVE SUMMARY

The Community Wildfire Protection Plan (CWPP) Program was created in British Columbia to aid communities in developing plans to assist in improving safety and to reduce the risk of damage to property. The 2003, 2004 2009, and 2010 BC wildfire seasons resulted in valuable economic, social and environmental losses. These losses have emphasized the need for greater consideration and due diligence with respect to fire risk in the wildland urban interface (WUI). While there are common themes that contribute to the risk profile of communities across BC, each community has unique aspects that require consideration during the CWPP process. Understanding the factors that contribute to wildfire risk is important in developing a comprehensive plan to identify and reduce wildfire risk.

In 2014, B.A. Blackwell and Associates Ltd. were retained by the Powell River Regional District (Regional District) to develop a CWPP. 'FireSmart – Protecting Your Community from Wildfire'[1] was used to guide the protection planning process. The scope of this project included three distinct phases:

I. Assessment of fire risk and development of a Wildfire Risk Management System (WRMS) to spatially quantify the probability and consequence of wildfire;
II. Consultation with key Regional District Staff (including but not limited to the District's Fire Protection Services) to assist with defining the Regional District's objectives for wildfire protection, and to develop mitigation strategy alternatives that would best meet the Regional District's needs.
III. Development of a plan which outlines measures to mitigate the identified risk through communication and education programs, structure protection, emergency response and management of forestlands adjacent to the community.

Two methods were used to assess risk to the study areas: 1) a geographic information system (GIS) model was used to spatially define risk according to probability of wildfire and consequence of wildfire; and 2) the Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) system was used to identify larger, relatively homogeneous polygons and rate their threat using the Wildland Urban Interface Wildfire Threat Assessment Worksheets. Both methodologies were based initially on the Provincial Strategic Threat Analysis (PSTA) data. In general, wildfire risk throughout the study area is predominantly high. Urban interface areas such as the City of Powell River rank moderate with a minor occurrence of extreme fire risk in isolated parts of the study area.

Four key areas where enhancements can be made to address community wildfire risk are reviewed in this plan: 1) Communication and Education; 2) Structure Protection and Planning; 3) Emergency Response; and 4) Vegetation/Fuel Management. Measures are outlined and prioritized for each of these areas. A total of 32 priority recommendations are made for the Powell River Regional District to reduce the community's risk profile when implemented.

[1] Partners in Protection. 2004. FireSmart Protecting your Community from Wildfire. http://www.partnersinprotection.ab.ca/downloads/inded.php

KEY RECOMMENDATIONS

Communication and Education			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: Improve public understanding of fire risk and personal responsibility by increasing resident awareness of wildfire threat in their community.			
1	High	• Employ a Fire Prevention Officer to deliver education programs and coordinate fire prevention information throughout the Regional District.	~$75,000 annually
2	High	• Provide FireSmart education materials to the point of issuing building permits through the support of the City of Powell River so that people know the fire hazard where they are building and what they can do to reduce those hazards.	See recommendation #1 + maintenance
3	High	• Develop a demonstration FireSmart property in a central location in the Regional District to provide homeowners with a working example of what a FireSmart home and property looks like and how it can be achieved.	See recommendation #1
4	High	• Upgrade the Regional District website to display or link wildfire prevention information and display real time information on fire bans and high fire danger, and provide a link to FireSmart information.	See recommendation #1 + maintenance
5	High	• Utilize social media (*e.g.*, Facebook, Twitter, etc.) to communicate fire bans, high fire danger days, wildfire prevention initiatives and other real time information.	Within current operating costs
6	High	• Review and update wildfire preparedness education in elementary and high schools.	See recommendation #1 + maintenance
7	Moderate	• Fire Departments should rate houses on suitability for triage and share rating information and recommendations with homeowners in high hazard areas.	Within current operating costs
8	Moderate	• Post information from the CWPP on the Regional District website showing areas with hazardous fuel complexes.	Within current operating costs
9	Low	• Install educational signage in high fire ignition areas.	$5,000 + maintenance
10	Low	• Encourage more frequent visits by Fire Departments during high and extreme fire danger times to high ignition areas.	See recommendation #1 + maintenance
Objective: Enhance the awareness of elected officials and stakeholders regarding the resources required and the risk that wildfires pose to communities.			
11	High	• Establish a Wildfire Suppression Group (Regional District, Fire Departments, MFLNRO WMB, BC Hydro and forest operator representatives) to identify wildfire related issues within the Regional District, resource deficiencies, and to allow for a coordinated approach to wildfire mitigation. This committee can be organized by the Fire Prevention Officer.	See recommendation #1

Structure Protection and Planning			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: Improve the FireSmart conditions and suppression access for interface areas to meet NFPA 1142 (Water Supplies for Suburban and Rural Fire Fighting) and 1144 (Protection of Life from Wildfire) standards.			
12	High	• Encourage residents to adopt FireSmart principles on their property.	See recommendation #1 + maintenance
13	High	• Review all critical infrastructure and prioritize upgrades where required.	Within current operating costs + upgrade costs
14	High	• New subdivisions should be developed with access suitable (2-way in and out; adequate width and turnaround for emergency vehicles) for evacuation and the movement of emergency response equipment.	Within current operating costs
15	Moderate	• Development and implementation of a Wildfire Hazard Development Permit Area that requires FireSmart building practices in moderate and high hazard areas.	$30,000 (one time cost) + maintenance
16	Moderate	• Create a spatial database of all critical infrastructure and review all critical infrastructure for fire vulnerability to help reduce structure loss.	$5,000 (one time cost) + maintenance
Objective: BC Hydro completes annual pre-fire season assessments and mitigation of right-of-ways to reduce the potential for ignition and power loss.			
17	High	• Engage with BC Hydro to coordinate and support annual assessments and mitigation of fire hazards along BC Hydro right-of-ways.	See recommendation #1

Emergency Response			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: Improve wildland equipment and enhance fire suppression capabilities across the Regional District.			
18	High	• Support the acquisition of a Regional District shared Sprinkler Trailer resource and provide sprinkler deployment training for all department members. The kit should be able to protect up to 30 interface homes.	$40,000 (one time cost)
19	High	• Support the acquisition of an interface appropriate fire truck for the Northside Fire Department.	$150,000 (one time cost)
20	High	• Maintain current structural and interface training with all Fire Departments and MFLFNRO WMB, and conduct annual reviews to ensure PPE is complete. Interface training should include completion of a mock wildfire scenario in coordination with MFLNRO WMB.	Within current operating costs

Emergency Response			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
21	High	• The Regional District should consider developing an Evacuation Plan in coordination with the RCMP to: map and identify safe zones, marshalling points and aerial evacuation locations; plan traffic control and accident management; identify volunteers that can assist during and/or after evacuation; and create an education/communication strategy to deliver this information to residents. Additionally, the Regional District is encouraged to engage with BC Ferries to explore options and plans to utilize and depend on BC Ferries to assist with community evacuation.	$7,000 + maintenance
22	Moderate	• Support the creation of two career fire fighter positions for the City of Powell River Fire Department toward meeting the four person minimum for a responding company under NFPA 1710.	$150,000 (annually)
23	Moderate	• Support on-call staff recruitment and training for the Tla'amin Fire Department.	Within current operating costs
24	Moderate	• The Regional District should consider supporting options for water access or water storage enhancements for firefighting throughout the Regional District, including increasing the number of hydrants in Malaspina.	Determined based on need
25	Moderate	• Encourage homeowners to post house numbers in a manner that makes them clearly visible to aid emergency response.	Within current operating costs

Vegetation Management			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: Reduce wildfire threat on private and public lands through vegetation management.			
26	High	• The Regional District should work with/encourage BC Hydro to reduce fire risk along Hydro right-of-ways. BC Hydro should ensure that transmission infrastructure can be maintained and managed during a wildfire event.	See recommendation #1
27	High	• The Regional District should encourage BC Hydro to ensure that the ROW vegetation management strategy considers managing Scotch broom beneath transmission lines that contribute to unacceptable fuel loading and diminished the ability of the ROW to act as a fuel break.	Within current operating costs
28	High	• The Regional District should identify potential partnerships to fund a vegetation management program and encourage UBCM to re-instate funding for vegetation management.	Within current operating costs

Vegetation Management			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
29	High	• The Regional District should consider establishing a fund to develop and implement a vegetation management program and for future maintenance.	$25,000 annually
30	High	• Based on funding availability, the Regional District should prioritize vegetation management prescription development in the identified high hazard areas (Priority 1 and Priority 2) with the support of a qualified professional forester.	Determined based on need and funding
31	High	• Use a combination of bylaws/development permit areas and public education to encourage private land owners to reduce the fire hazard on their properties.	See recommendation #1
32	Moderate	• The Regional District should work with forest operators (*e.g.*, licensees, woodlot operators, private land owners, *etc.*) to reduce fire risk in their operating areas and work with the MFLNRO WMB to enforce hazard abatement as outlined in the Wildfire Act and Regulation, specifically within 2 km of the interface zone.	See recommendation #1

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1.0 INTRODUCTION

The Community Wildfire Protection Plan (CWPP) Program was created in British Columbia (BC) to aid communities in developing plans to assist in improving safety and to reduce the risk of damage to property. The Program was developed in response to recommendations from the "Firestorm 2003 Provincial Review"[2].

The 2003, 2004, 2009, and 2010, BC wildfire seasons resulted in valuable economic, social and environmental losses. These losses emphasized the need for greater consideration and due diligence with respect to fire risk in the wildland urban interface (WUI). In considering the wildfire risk in the WUI, it is important to understand the unique risk profile of a given community. While there are common themes that contribute to the risk profile of communities across BC, each community has unique aspects that require consideration during the CWPP process. Understanding the factors is important in developing a comprehensive plan to identify and reduce wildfire risk. The 2003 Okanagan Park fire and the 2011 fire in Slave Lake, Alberta demonstrated that the consequences of a WUI fire can be very significant in communities and that proper consideration and pre-planning is vital to reducing the impacts of wildfire.

In 2014, B.A. Blackwell and Associates Ltd. were retained by the Powell River Regional District (Regional District) to develop a CWPP. 'FireSmart – Protecting Your Community from Wildfire'[3] was used to guide the protection planning process. The assessment considers important elements of community wildfire protection planning, including communication, structure protection, emergency response and vegetation management. This CWPP will provide the Regional District with a framework that can be used to identify methods and guide future actions to mitigate fire risk in the community. The scope of this project included three distinct phases:

I. Assessment of fire risk and development of a Wildfire Risk Management System (WRMS) to spatially quantify the probability and consequence of fire;

II. Consultation with key Regional District Staff (including but not limited to the Regional District's Fire Protection Services and Emergency Coordinator) to assist with defining the objectives for wildfire protection, and to develop the mitigation strategy alternatives that would best meet the Regional District's needs.

III. Development of the Plan which outlines measures to mitigate the identified risk through communication and education programs, structure protection, emergency response and management of forestlands adjacent to the community.

[2] http://bcwildfire.ca/History/ReportsandReviews/2003/FirestormReport.pdf

[3] Partners in Protection. 2004. FireSmart Protecting your Community from Wildfire. http://www.partnersinprotection.ab.ca/downloads/inded.php

2.0 COMMUNITY WILDFIRE PROTECTION PLANNING PROCESS

This CWPP document will review the background information related to the study area. This includes communities along the southern coast of the Regional District, the City of Powell River the Tla'amin Reserve, Lund and Saltery Bay. The CWPP development consists of six general phases:

- Background research - general community characteristics, such as demographic and economic profiles, critical infrastructure, environmental and cultural values, fire weather, fire history, relevant legislation and land jurisdiction.
- Field work - site visits to the area allow for 1) meetings with Regional District staff and Tla'amin First Nation; 2) fuel typing; 3) ground truthing of background research; 4) completing hazard assessment forms, and 5) identification of site specific issues.
- GIS analyses - digital fuel typing and mapping of probability and consequence of fire, and community wildfire risk.
- Report and map development - identification of Regional District challenges and successes, identification of measures to mitigate risks, and recommendations for action.
- Report review - by Regional District staff and Council, Tla'amin First Nation, and Wildfire Management Branch (WMB)

The compiled information on the study area is used in a spatial model (WRMS). The output of the WRMS is a series of maps that characterize the probability of fire and the potential consequences of fire. The final map is a combination of all the probability and consequence layers and shows the levels of risk in the community. This is called the community risk profile, and reducing the level of risk is the main focus of the CWPP. The figure below demonstrates how the community risk profile is derived and what measures are considered in reducing risk (Figure 1). The end result is the implementation of recommendations using the various planning tools to lower the wildfire risk faced by the community. The Action Plan (Section 8.0) specifically addresses the five elements of a CWPP that contribute to risk reduction. It makes specific recommendations (planning tools) on how risk can be reduced by making changes to these five elements.

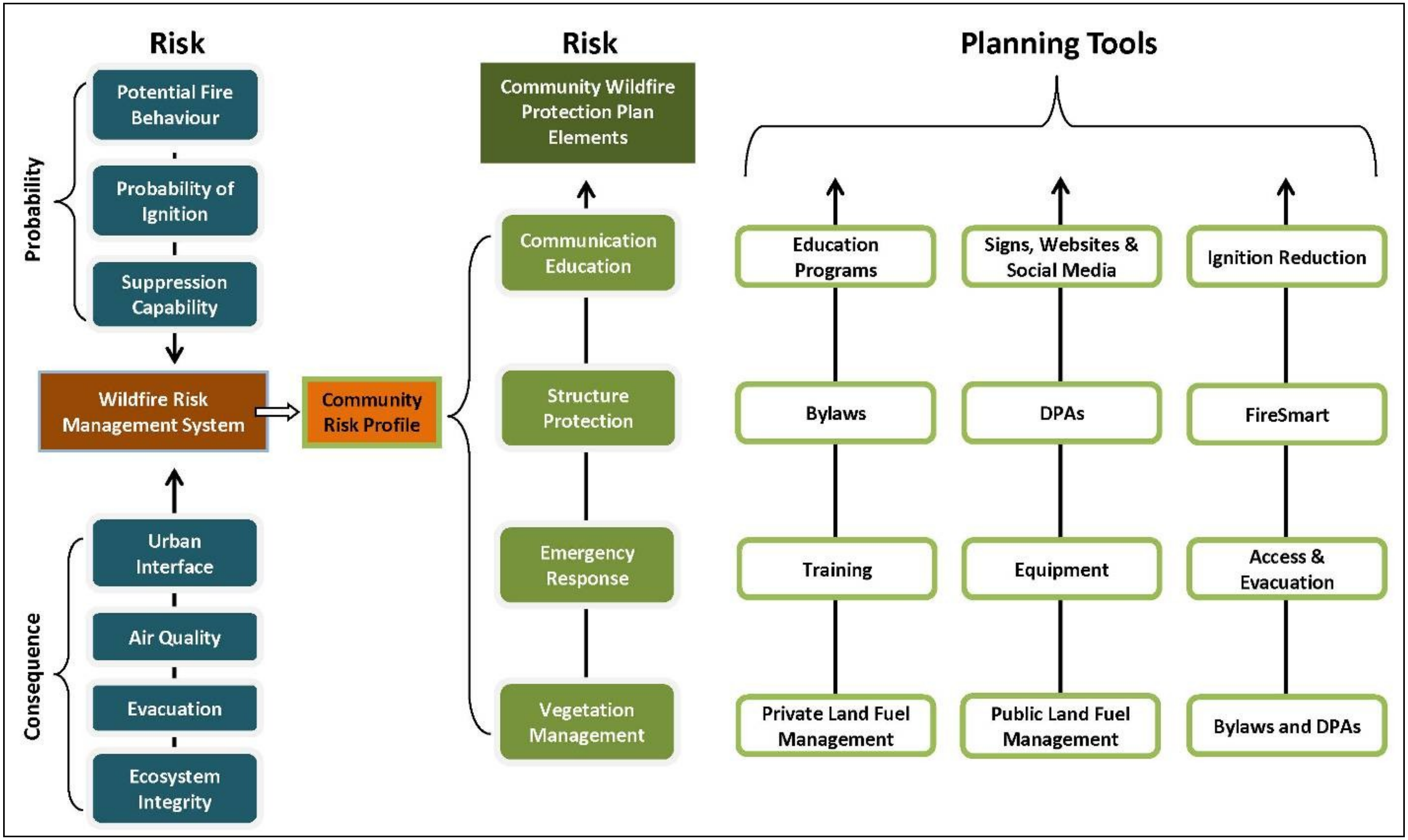


Figure 1. CWPP planning structure used to translate the community risk profile into action that will reduce the community wildfire risk.

3.0 REGIONAL DISTRICT PROFILE

The Powell River Regional District is located on the west coast of BC, on the upper Sunshine Coast, and is within the traditional territory of the Tla'amin First Nation. The Regional District includes five electoral areas and one municipality (City of Powell River), and covers an area of approximately 5,000 km^2. The Regional District's population as of 2011 was almost 20,000 with a population density of 3.9/km^2.[4] The Tla'amin First Nation comprises approximately 3.8% of the Regional District population. The Tla'amin First Nation is part of the Coast Salish indigenous people's territory and the main reservation (IR #1) is located between the City of Powell River and Lund. The Tla'amin community has approximately 1,200 members.[5]

The administrative boundaries of the Regional District include the City of Powell River, Electoral Areas A – E and the Tla'amin First Nation. The study area for this Plan is restricted to the mainland area of the Regional District (Map 1). This includes Electoral Areas A, B and C, the City of Powell River and Tla'amin IR #1 (Map 1). These areas include the WUI areas within the Regional District.

The study area also includes Crown and private forest lands, and land within the Agricultural Land Reserve (ALR). The forested lands include the Tla'amin First Nation license and a portion of Timber Farm License (TFL) 39 which is held by Western Forest Products. The portion of the TFL which is within the study area is referred to as Block 1. The forests of Block 1 are generally within the Coastal Western Hemlock (CWH) biogeoclimatic zone and include second growth timber and old forests. Management of Block 1 is subject to the Vancouver Island Land Use Plan Higher Level Plan Order[6]. The study area is accessible by road, connecting ferries, and airport service.

[4] https://www12.statcan.gc.ca/census-recensement/2011

[5] http://www.sliammonfirstnation.com/

[6] http://www.westernforest.com/wp-content/uploads/stewardship/TFL%2039_MP9_draft_v1.pdf

Map 1. Overview of the Community Wildfire Protection Plan study area for the Powell River Regional District.

3.1 INFRASTRUCTURE

Protection of infrastructure during a wildfire event is important to ensure that emergency response is as effective as possible, to ensure coordinated evacuation can occur if necessary, and essential services in the study area can be maintained and/or restored quickly. Critical infrastructure includes emergency services, water, electrical service, transportation, and communications infrastructure. Additional critical infrastructure includes schools and government offices.

Within the study area, emergency services include one R.C.M.P detachment, 911 service (police, ambulance or fire), the Powell River General Hospital (a 33-bed facility), and four fire departments.

Fire department summaries:

- The City of Powell River Fire Department (located at 6965 Courtenay Street) has two active fire halls with 12 paid career staff, one Deputy Officer, one Chief Officer, one Office Coordinator and approximately 40 paid on-call auxiliary staff. The Department is currently operating without a Fire Prevention Officer and currently has no fully staffed trucks.

- The Malaspina Volunteer Fire Department (located on the Sunshine Coast Highway) has two active fire halls with 25 on-call staff which include one Deputy Officer and a Chief Officer.

- The Northside Volunteer Fire Department (located on Marine Avenue) has two active fire halls and 22 on-call staff which include one Deputy Officer and a Chief Officer.

- The Tla'amin Fire Department is located on Tla'amin IR #1 and they currently have eight regular on-call staff.

The Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) Wildfire Management Branch (WMB) has a base located in the City of Powell River. The WMB base in Powell River has two officers, one Initial Attack, and two on-call paid staff.

Electrical service is received through a network of wood pole transmission and distribution infrastructure supplied through BC Hydro. Wood pole distribution lines (small, street-side poles) connecting homes and subdivisions would be vulnerable to fire, which could disrupt service to portions of the community. The invasive shrub Scotch broom (*Cystis scoparius*), is present under transmission and distribution lines however broom only sustains fire at the highest fire weather indices.

The Regional District owns, operates and maintains water and sewer infrastructure. The Regional District's water treatment plant has a back-up generator that can be used in the case of a power failure. Many residence outside of the Regional District's core, rely on wells, septic tanks and on-site sewage treatment. Significant water systems within the study area in terms of providing reliable water supplies for firefighting include:

- Lund Waterworks (serves the residential areas around the Village of Lund);
- Tla'amin Nation Water Supply (serves the Tla'amin Nation community centre and Klahanie lease lands);
- City of Powell River Water System(serves the entire City);
- Myrtle Pond Water System (administered by the Regional District, serves the residential area around Myrtle Pond); and
- Brew Bay Improvement District (serves the residential area around Brew Bay Road).

Figure 2. Examples of critical infrastructure located in the Powell River Regional District (left: Land Sewer Treatment Plant; right: electrical distribution subsystem).

Many communities have concerns related to water quality and possible contamination of water supplies through the use of fire retardants. The following discussion on the effects of fire retardants on water quality is taken from a peer reviewed compendium. Additional sources were reviewed in the literature and support the summary presented below.

Fire retardants used in wildfire suppression are generally ammonium phosphate or ammonium sulphate based with other chemical to reduce corrosion. Retardant use has been shown to elevate NH_4, PO_4^{3-} and NO_3^- concentrations in water but only for short periods of time (< 1 hour). Ferrocyanides are one of the main concerns in regards to water quality, In the presence of UV radiation, decomposition of this chemical can occur resulting in cyanide ion release. However, the concentrations are unlikely to result in toxic levels unless soils are coarse and organic content is low (Pike *et al.*, 2009). In summary, the effects of retardants appear to be of limited time frame with little potential impact upon drinking water. However, as the authors note, research on the topic is limited. While the impact of fire suppressants upon the Regional District's wells and watershed may be minimal or non-existent, fire suppression should favour water over chemical suppressants if fire behaviour, safety, and structure protection permit.

Considering the location of the study area on the mainland, it can only be reached via air or water as there is no direct road access from the lower Sunshine Coast. The airport is located in the City of Powell River which charters flights onto the mainland and Vancouver Island. The Sunshine Coast Highway (Hwy 101) is the only major highway in the Regional District and connects Powell River to the Saltery Bay – Earls Cove ferry. There are two ferries out of Powell River to Comox on Vancouver Island and Texada Island which is part of the Regional District's Electoral Area D. Areas such as Sarah Point face greater access challenges with one-way access that is not paved. Considering the limited egress, there is a potential for the community to become isolated during an active wildfire event. Pre-evacuation planning and swift implementation of evacuation orders during a wildfire event is important to ensure safety and timely evacuation of the population.

3.2 ENVIRONMENTAL & CULTURAL VALUES

Environmental and cultural values are high throughout the study area. The Regional District offers a range of outdoor activities that draw tourists from around the Province. These activities include mountain biking, golfing, fishing, camping and hiking. The Regional District also provides access to well-developed trail networks such as the Sunshine Coast Trail. Cultural values within the study area include the Tla'amin traditional lands which include fish bearing habitat and sites of cultural significance. Other values within the study area include heritage buildings, Crown and private forest lands and land that are administered by the Provincial Agricultural Land Commission (ALC), where the ALC is responsible for the administration of the *Agricultural Land Commission Act*. This land is part of the Agricultural Land Reserve (ALR).

Subdivision and land use within the ALR is regulated by the ALC and the priority use of this land is for agriculture.[7] The value of ALR lands, which include farmed, forested or vacant lands, are valuable to the community and the Province. A significant wildfire would result in an impact on various values at risk throughout the study area, including valuable forest and farmland.

The Conservation Data Centre (CDC), which is part of the Environmental Stewardship Division in the Ministry of Environment, is the repository for information related to plants, animals and ecosystems at risk in BC. To identify species and ecosystems at risk within the study area the CDC database was referenced. Two classes of data are kept by the CDC: non-sensitive occurrences for which all information is available (species or ecosystems at risk and location); or masked sensitive occurrences where only generalized location information is available. Only non-masked data was used in the report.

Throughout the Powell River Regional District (including the study area), there are approximately 74 listed species. Twenty-two of these species are on the BC Red List and 47 are on the BC Blue List. These listed species include but are not limited to mammals, breeding birds, fishes, vascular plants, insects, mollusks and amphibians.

All future fuel treatment activities or activities associated with recommendations made in this plan should consider the presence and impact on all potentially affected species. Additionally, any developed fuel management prescriptions should identify any relevant masked (sensitive occurrences) species and manage fuel treatment activities to mitigate any potential impacts on species at risk. It is also worthy to note that Scotch broom (an upright, taprooted evergreen shrub that can grow up to 3 m tall) is invasive and can displace native plant species on disturbed sites[8].

[7] http://www.alc.gov.bc.ca/index.htm

[8] http://bcinvasives.ca/invasive-species/identify/invasive-species/invasive-plants/scotch-broom/

3.3 BIOGEOCLIMATIC UNITS

The Biogeoclimatic Ecosystem Classification (BEC) system describes zones by vegetation, soils and climate. Regional subzones are derived from relative precipitation and temperature. The study area is defined by four Regional subzones[9]:

- CDFmm: The coastal portion of the study area is defined by the regional climate of the Coastal Douglas-fir moist maritime (CDFmm). The CDFmm is characterized by warm, dry summers and mild wet winters. The growing seasons are very long and there are pronounced water deficits on zonal or drier sites (Green and Klinka, 1994). The relatively limited extent of the CDFmm and extensive urbanization of this area has resulted in habitat loss and degradation to these ecosystems.

- CWHdm: The northern edge of the study area is primarily defined by the Coastal Western Hemlock (CWH) dry maritime subzone. These areas are characterized by warm, relatively dry summers and moist, mild winters with little snowfall. The growing seasons are long with only minor water deficits on zonal sites.

- CWHvm2: There is a small pocket along the northeastern edge of the study area that is defined by the CWH very warm maritime (CWHvm). The CWHvm2 generally has a wet and humid climate with cool, short summers, cool winters, and a short growing season.

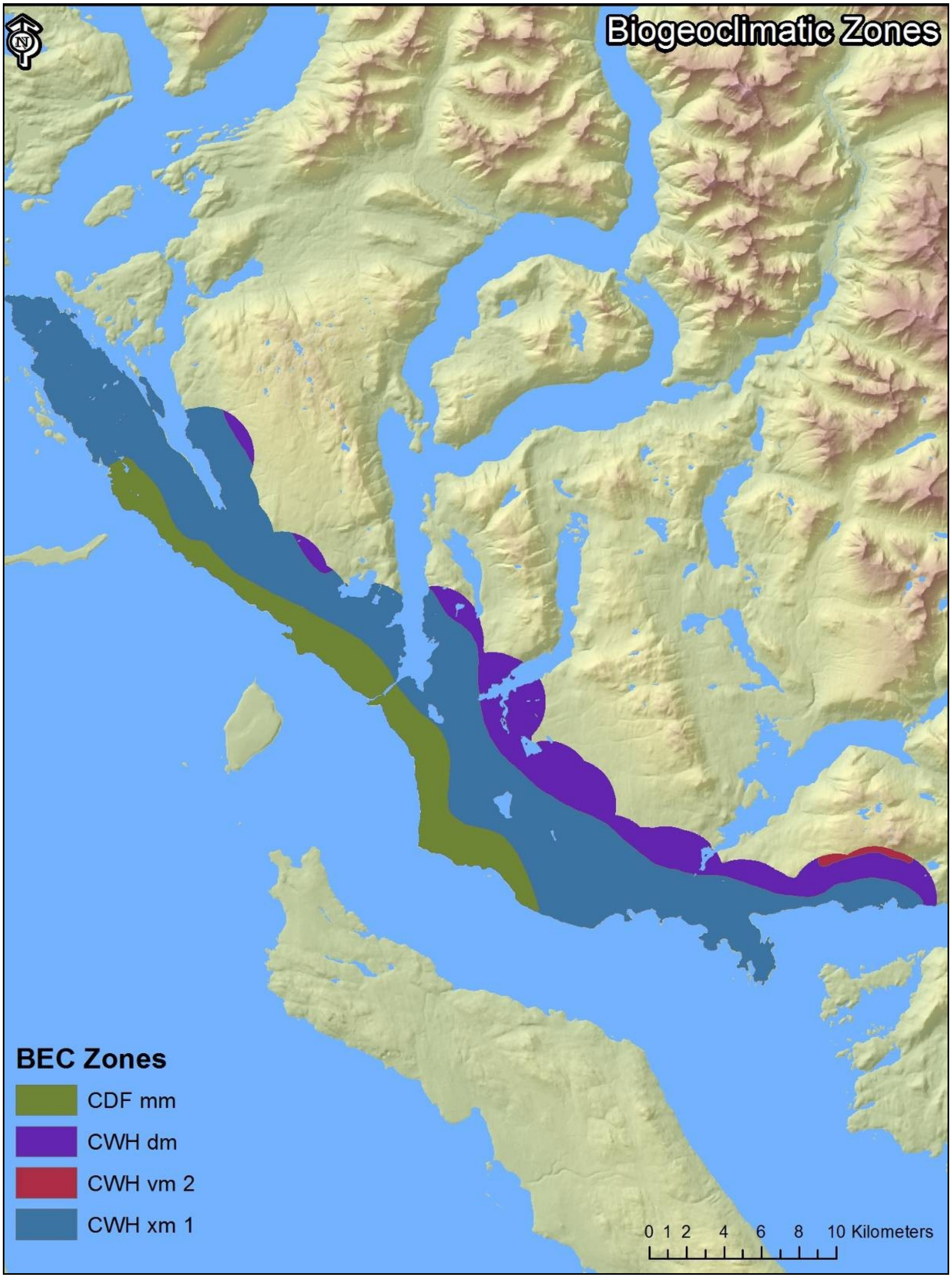
- CWHxm1: The majority and interior portion of the study area is defined by the CWH very dry maritime (CWHxm). The CWHxm is characterized by warm, dry summers and moist, mild winters with relatively little snowfall. Growing seasons are similar to those of the CDFmm with water deficits on zonal sites. The CWH is the most productive forest region in Canada and in the drier portion of this zone many conifers exhibit their best growth.

3.4 NATURAL DISTURBANCE TYPES

BEC zones have been used to classify the Province into five Natural Disturbance Types (NDTs). Natural NDTs have influenced the vegetation dynamics and ecological functions and pathways that determine many of the characteristics of our natural systems. The physical and temporal patterns, structural complexity, vegetation communities, and other resultant attributes should be used to help design fuel treatments, and where possible, to help ensure that treatments are ecologically and socially acceptable.

The study area ecosystems are classified as NDT 2 where ecosystem experience infrequent stand-initiating events. Generally these ecosystems are exposed to wildfires of moderate size that typically leave unburned areas. The mean disturbance return interval for these ecosystems is approximately 200 years. Although the fire frequency is not high and fires are not large, pre-planning and preparation are essential to reduce the negative impacts of a wildfire.

[9] Green and Klinka. 1994. A Field Guide for Site Identification and Interpretation for the Vancouver Forest Region. Land Management Handbook #28. BC MFLNRO.



Map 2. Illustration of the Powell River Regional District study area biogeoclimatic ecosystem classification (BEC) zones.

3.5 PAST WILDFIRE RELATED PROJECTS

Past wildfire related projects are limited in the study area however the Regional District is working towards a state of improved preparedness and training for wildfire emergencies. Wildfire-related progress has been in the area of general emergency planning. This has included the development of the *Powell River Regional Emergency Plan – Emergency Operations Centre Response Guidelines* (2013) which follows the Guiding Principles of the BC Emergency Response Management System (BCERMS). The plan was mandated as part of the emergency management response system endorsed by the Province. A CWPP was also completed for Savary Island in 2009 by B.A. Blackwell & Associates Ltd. Based on recommendations of the Savary Island CWPP, Savary is the only part of the Regional District where fuel management activities have been developed and implemented. Savary is not part of the study area for this Plan.

Select fire departments within the study area have generally organized events such as a fire prevention week or participate in fire education for elementary school children; however enhancing wildfire related projects throughout the study area will be beneficial. The development of this Plan is a valuable and key step in moving forward with the emergency planning and wildfire risk mitigation process. Recommendations will aid with guiding future wildfire related projects.

Communication, support and coordination among fire departments and with MFLNRO are good. The level of coordination and support of fire suppression resources is an asset to the communities within the study area.

3.6 FOREST HEALTH

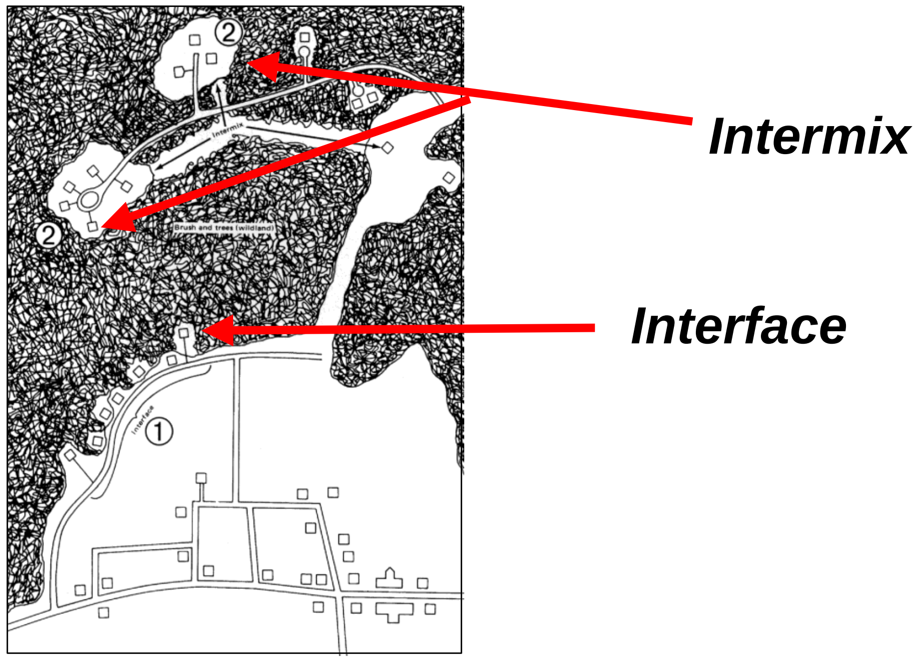
There are no major forest health issues of concern throughout the study area. Common biotic forest health factors present include the Douglas-fir bark beetle (*Pseudotsuga menziessi*) in mature Douglas-fir trees and laminated root rot in young Douglas-fir plantations. Considering the general stand composition of the study area (mix of coniferous and deciduous stands), and the limited extent and intensity of current forest health factors, cumulative effects are not considerable.

Figure 3. Douglas-fir trees killed by Douglas-fir bark beetle.

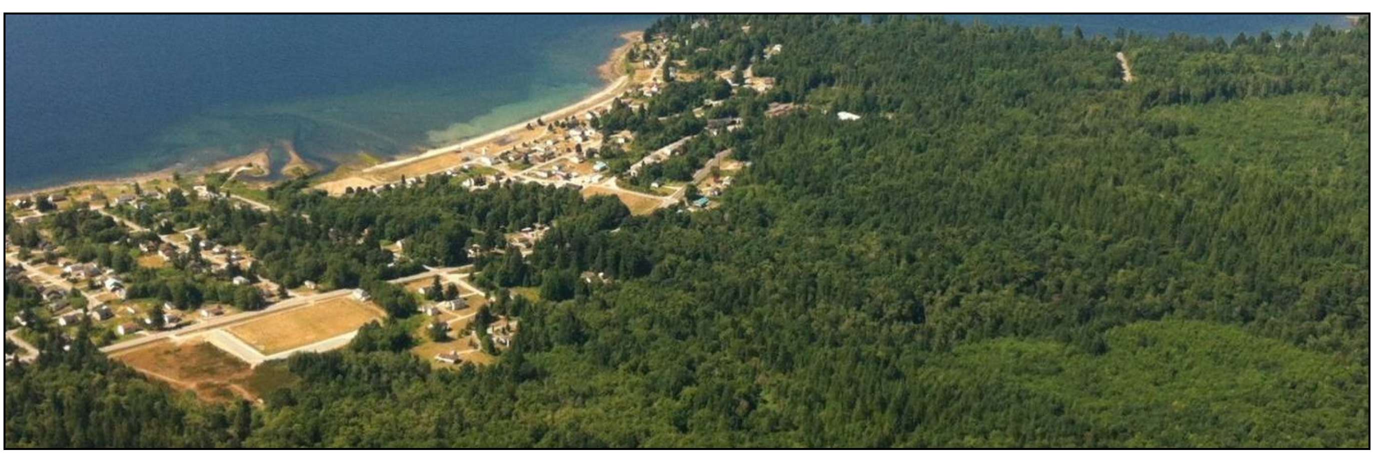
4.0 THE WILDLAND URBAN INTERFACE

The WUI is generally defined as the place where the forest meets the community, and smaller, more isolated developments that are embedded within the forest are referred to as intermixed area which is a configuration of the WUI. An example of interface and intermixed areas is illustrated in Figure 4.

Figure 4. Illustration of intermix and interface areas.



In interface and intermixed communities, fire has the ability to spread from the forest into the community or from the community out into the forest. Although these two scenarios are quite different, they are of equal importance when considering interface fire risk. Within the study area, the probability of a fire moving out of the community and into the forest is equal or greater to the probability of fire moving from the forest to the community. Regardless of which scenario occurs, there will be consequences for the community and this will have an impact on the way in which the community plans and prepares for interface fires.



4.1 VULNERABILITY OF THE WILDLAND URBAN INTERFACE TO FIRE

Fires spreading into the WUI from the forest can impact homes in two distinct ways:

1. From sparks or burning embers getting carried by the wind, or convection that starts new fires beyond the zone of direct ignition (main advancing fire front), and alight on vulnerable construction materials (*i.e.* roofing, siding, decks etc.) (Figure 5).

2. From direct flame contact, convective heating, conductive heating or radiant heating along the edge of a burning fire front (burning forest), or through structure-to-structure contact. Fire can ignite a vulnerable structure when the structure is in close proximity (within 10 meters of the flame) to either the forest edge or a burning house (Figure 6).

Figure 5. Firebrand caused ignitions: burning embers are carried ahead of the fire front and alight on vulnerable building surfaces.

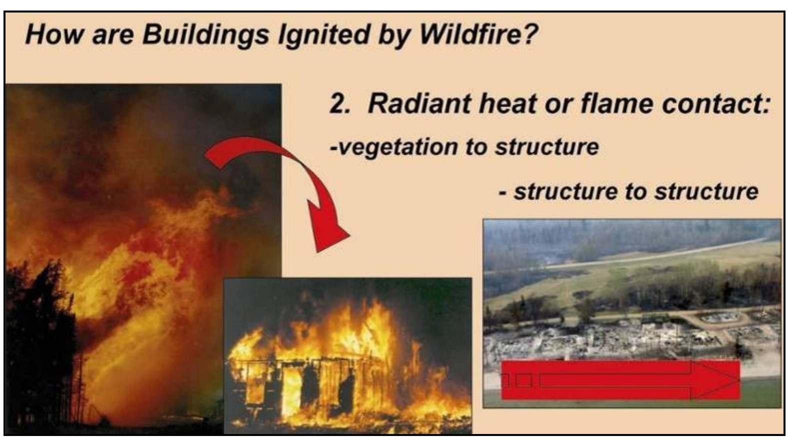


Figure 6. Radiant heat and flame contact allows fire to spread from vegetation to structure or from structure to structure.

5.0 FIRESMART

One of the most important areas with respect to forest fire ignition and the damages associated with a wildfire is the zone adjacent to buildings and homes. *FireSmart, Protecting Your Community from Wildfire*[10] is a guide developed by Partners in Protection that provides practical tools and information on how to reduce the risk of loss from interface fires. The FireSmart website can be visited at: www.firesmartcanada.ca.

We often consider wildfire an external threat to our residences; however in many cases fire can originate as a house fire and spread into the interface. In both cases, fire coming from the forest to a building or spreading from a building to the forest, home owners and businesses can take steps to reduce the probability of this occurring. There are two main avenues to FireSmart a home: 1) change the vegetation type, density, and setback from the building (fuel treatments and landscaping) and 2) change the structure to reduce vulnerability to fire and the potential for fire to spread to or from a building.[1]

5.1 FIRESMART STRUCTURE PROTECTION

An important consideration in protecting the WUI zone from fire is ensuring that homes can withstand an interface fire event. Often, it is a burning ember traveling some distance and landing on vulnerable housing materials (spotting), rather than direct flame contact (vegetation to house) or radiative heat that ignites a structure. Alternatively, the convective or radiant heating produced by one structure may ignite an adjacent structure if it is in close proximity. Structure protection is focused on ensuring that building materials and construction standards are appropriate to protect individual homes from interface fire. Materials and construction standards used in roofing, exterior siding, window and door glazing, eaves, vents, openings, balconies, decks, and porches are primary considerations in developing FireSmart neighbourhoods. Housing built using appropriate construction techniques and materials are less likely to be impacted by interface fires.[1]

While many BC communities established to date were built without significant consideration with regard to interface fire, there are still ways to reduce home vulnerability. Changes to roofing materials, siding, and decking can be achieved over the long-term through changes in bylaws and building codes.

The FireSmart approach has been adopted by a wide range of governments and is a recognized template for reducing and managing fire risk in the wildland urban interface. The most important components of the FireSmart approach are the adoption of the hazard assessment systems for wildfire, site and structure hazard assessment, and the proposed solutions outlined for vegetation management, structure protection, and infrastructure. Where fire risk is moderate or greater, at a minimum, the FireSmart standard should be applied to new subdivision developments and, wherever possible, the standard should be integrated into existing subdivisions and built up areas when renovations occur or landscaping is changed.

The following link accesses an excellent four minute video demonstrating the importance of FireSmart building practices during a simulated ember shower: http://www.youtube.com/watch?v=_Vh4cQdH26g.

[10] For further information regarding the FireSmart program see *www.pep.bc.ca/hazard_preparedness/FireSmart-BC4.pdf*

Roofing Material:[1]

Roofing material is one of the most important characteristics influencing a home's vulnerability to fire. Roofing materials that can be ignited by burning embers increases the probability of fire related damage to a home during an interface fire event.

In many communities, there is no fire vulnerability standard for roofing material. Homes are often constructed with unrated materials that are considered a major hazard during a large fire event. In addition to the vulnerability of roofing materials, adjacent vegetation may be in contact with roofs, or roof surfaces may be covered with litter fall from adjacent trees. This increases the hazard by increasing the ignitable surfaces and potentially enabling direct flame contact between vegetation and structures.

Building Exterior - Siding Material:[1]

Building exteriors constructed of vinyl or wood are considered the second highest contributor to structural hazard after roofing material. These materials are vulnerable to direct flame or may ignite when sufficiently heated by nearby burning fuels. Winds caused by convection will transport burning embers, which may lodge against siding materials. Brick, stucco, or heavy timber materials offer much better resistance to fire. While wood may not be the best choice for use in the WUI, other values from economic and environmental perspectives must also be considered. It is significantly cheaper than many other materials, supplies a great deal of employment in BC, and is a renewable resource. New treatments and paints are now available for wood that increase its resistance to fire and they should be considered for use.

Balconies and Decking:[1]

Open balconies and decks increase fire vulnerability through their ability to trap rising heat, by permitting the entry of sparks and embers, and by enabling fire access to these areas. Closing these structures off limits ember access to these areas and reduces fire vulnerability.

Combustible Materials:[1]

Combustible materials stored within 10 m of residences are also considered a significant issue. Woodpiles, propane tanks and other flammable materials adjacent to the home provide fuel and ignitable surfaces for embers. Locating these fuels away from structures helps to reduce structural fire hazards and makes it easier and safer for suppression crews to triage a house.

Figure 7. Example of a combustible material (propane tank) stored within 10 m of a residence.

5.2 FIRESMART FUEL TREATMENTS

One effective method of reducing how easily fire can move to and from a home is by altering the vegetation around the home (Figure 8). The following information regarding fuel treatments is based on the FireSmart Manual (Partners in Protection 2002).

Priority Zone 1 is a 10 m fuel free zone around structures. This ensures that direct flame contact with the building cannot occur and reduces the potential for radiative heat to ignite the building. While creating this zone is not always possible, landscaping choices should reflect the use of less flammable vegetation such as deciduous bushes, herbs and other species with low flammability. Coniferous vegetation such as juniper or cedar bushes and hedges should be avoided, as these are highly flammable. Any vegetation in this zone should be widely spaced and well setback from the house.

Priority Zone 2 extends from 10 to 30 m from the structure. In this zone, trees should be widely spaced 5 to 10 m apart, depending on size and species. Tree crowns should not touch or overlap. Deciduous trees have much lower volatility than coniferous trees, so where possible deciduous trees should be preferred for retention or planting. Trees in this area should be pruned as high as possible (without compromising tree health), especially where long limbs extend towards buildings. This helps to prevent a fire on the ground from moving up into the crown of the tree or spreading to a structure. Any downed wood or other flammable material should also be cleaned up in this zone to reduce fire moving along the ground.

Priority Zone 3 extends from 30 to 100 m from the home. The main threat posed by trees in this zone is spotting, the transmission of fire through embers carried aloft and deposited on the building or adjacent flammable vegetation. To reduce this threat, cleanup of surface fuels as well as pruning and spacing of trees should be completed in this zone (Partners in Protection 2002).

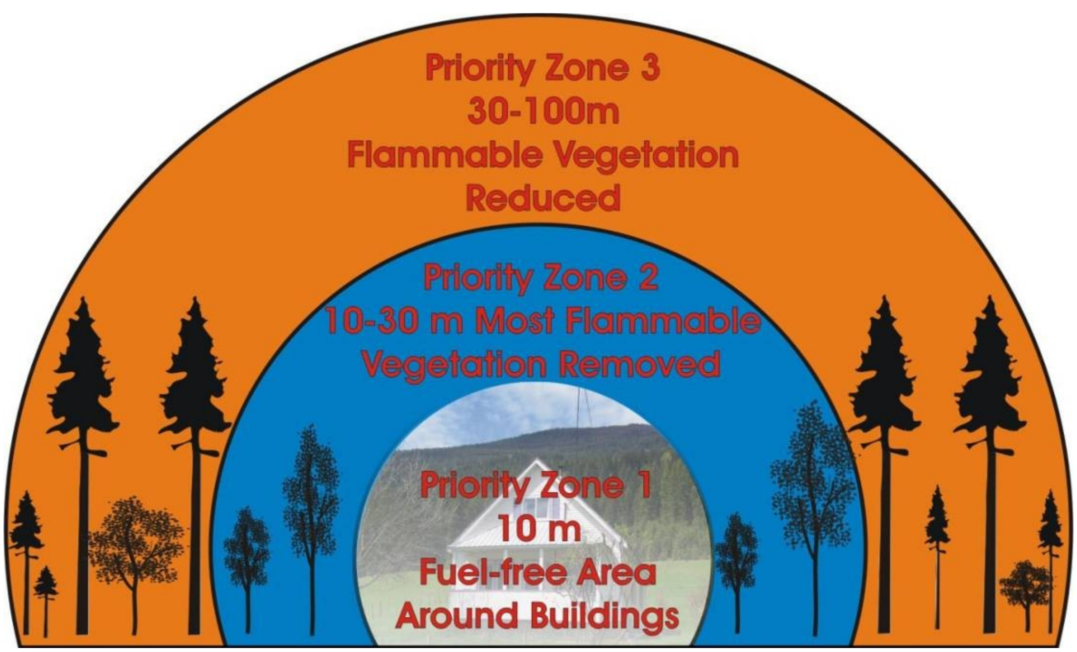


Figure 8. Illustration of FireSmart zones.
(Figure adapted from FireSmart)

6.0 FIRE ENVIRONMENT

6.1 FIRE WEATHER

The Canadian Forestry Service developed the Canadian Forest Fire Danger Rating System (CFFDRS) to assess fire danger and potential fire behaviour. A network of fire weather stations during the fire season are maintained by the Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) and are used to determine fire danger on forestlands within a community. The information can be obtained from the MFLNRO Protection Branch and is most commonly utilized by municipalities and regional districts to monitor fire weather, and to determine hazard ratings, associated with bans and closures.

Fire Danger Classes provide a relative index of how easy it is to ignite a fire and how difficult control is likely to be. The BC *Wildfire Act* [BC 2004] and *Wildfire Regulation* [BC Reg. 38/2005], which specify responsibilities and obligations with respect to fire use, prevention, control and rehabilitation, restrict high risk activities based on these classes. Fire Danger Classes are defined as follows:

- **Class 1 (Very Low)**: Fires are likely to be self-extinguishing and new ignitions are unlikely. Any existing fires are limited to smoldering in deep, drier layers.
- **Class 2 (Low)**: Creeping or gentle surface fires. Fires are easily contained by ground crews with pumps and hand tools.
- **Class 3 (Moderate)**: Moderate to vigorous surface fires with intermittent crown involvement. They are challenging for ground crews to handle; heavy equipment (bulldozers, tanker trucks, and aircraft) are often required to contain these fires.
- **Class 4 (High)**: High-intensity fires with partial to full crown involvement. Head fire conditions are beyond the ability of ground crews; air attack with retardant is required to effectively attack the fire's head.
- **Class 5 (Extreme)**: Fires with fast-spreading, high-intensity crown fire. These fires are very difficult to control. Suppression actions are limited to flanks, with only indirect actions possible against the fire's head.

It is important to highlight that the likelihood of exposure to periods of high fire danger, defined as Danger Class 4 (High) and 5 (Extreme), are important to identify in order to determine appropriate prevention programs, levels of response, and management strategies. The study area lies in an ecosystem with relatively high annual precipitation and high biological productivity. This creates a situation with generally low fire hazard but with complexes of high fuel loading which can become potentially very hazardous during times of summer drought or drier fire weather. Danger Class days were summarized to provide an indication of the fire weather in the study area and it is worthy to note that fire danger in the study area can vary from season to season.

Considering fire danger varies from year to year, historical weather data can provide information on the number and distribution of days when the study area is typically subject to high fire danger conditions, which is useful information in assessing fire risk.

Average Danger Class days for each month of the fire season (May – September) are illustrated in Figure 9.. Data was provided by the MFLNRO WMB. Thirty-three years of data (1982 – 2014) from the Powell River weather station was used to summarize fire weather for the Regional District. On average, the greatest numbers of Moderate (DC III) and High Danger Class (DC IV) days generally occur during July and September, and most extreme fire weather is experienced between late July and mid-August. During August there is less than a 5% probability of the occurrence of extreme (DC V) fire weather and there is nearly a 30% probability of high (DC IV) or greater. After August there is a rapid decline in the probability of high or extreme ratings.

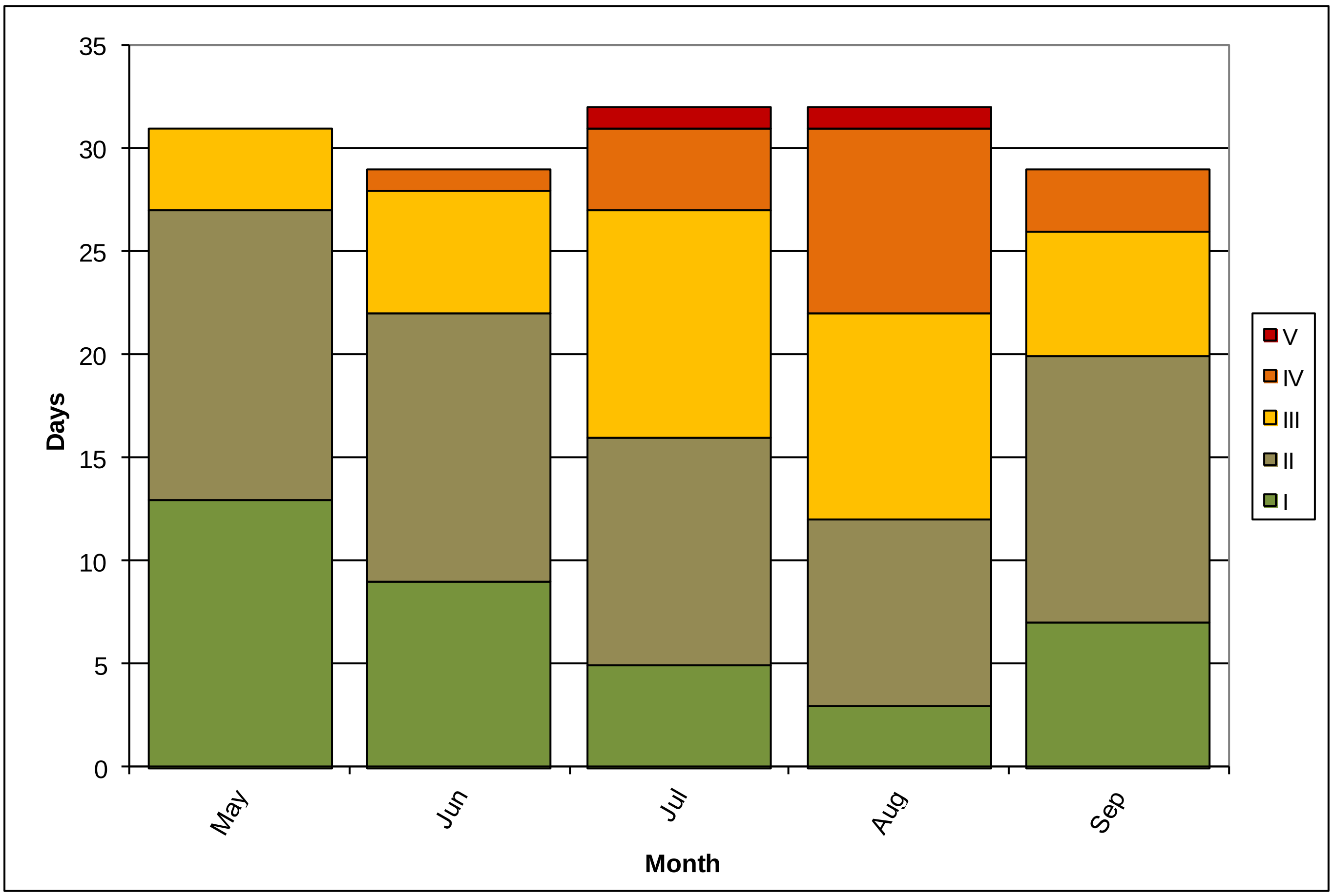


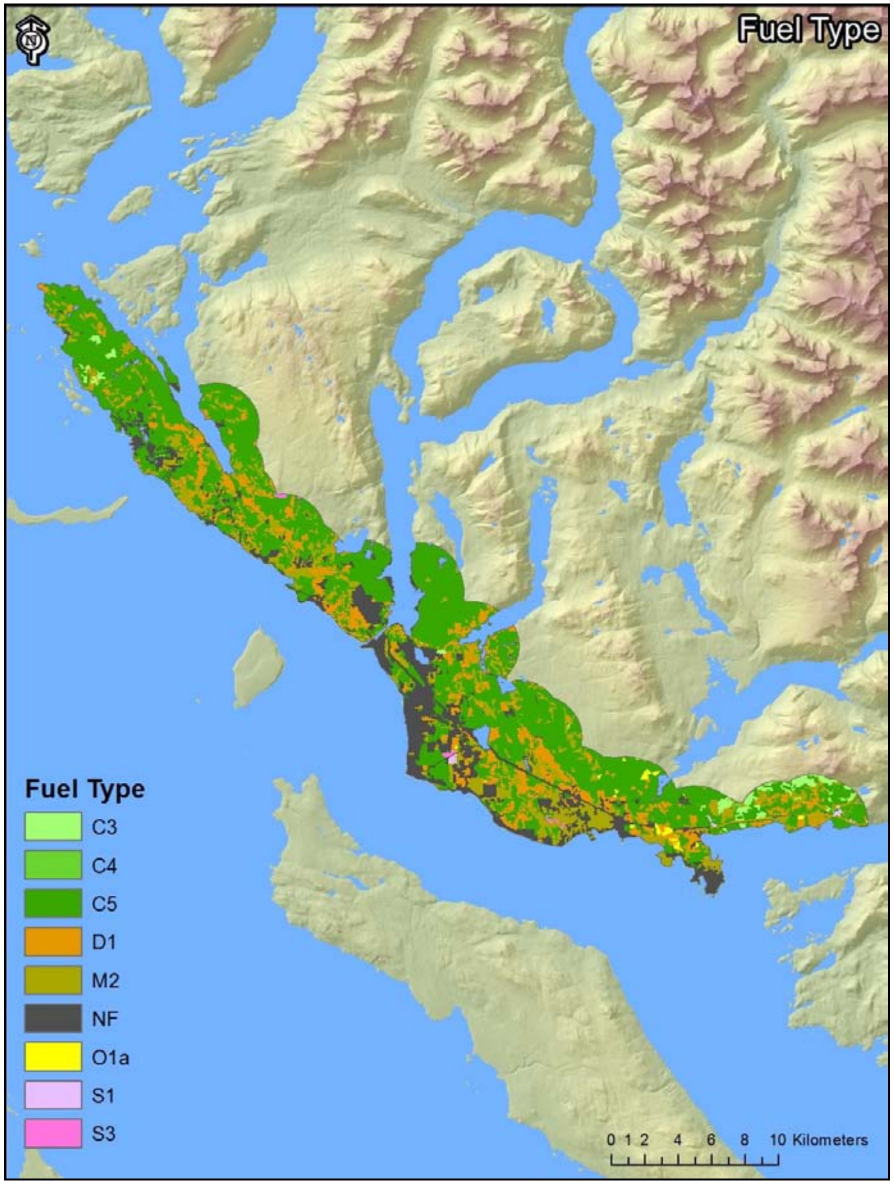
Figure 9. Probability of Fire Danger Class ratings averaged by month over a 33-year period (1982 – 2014) from the Powell River weather station.

6.2 FUEL TYPES & HISTORIC IGNITIONS

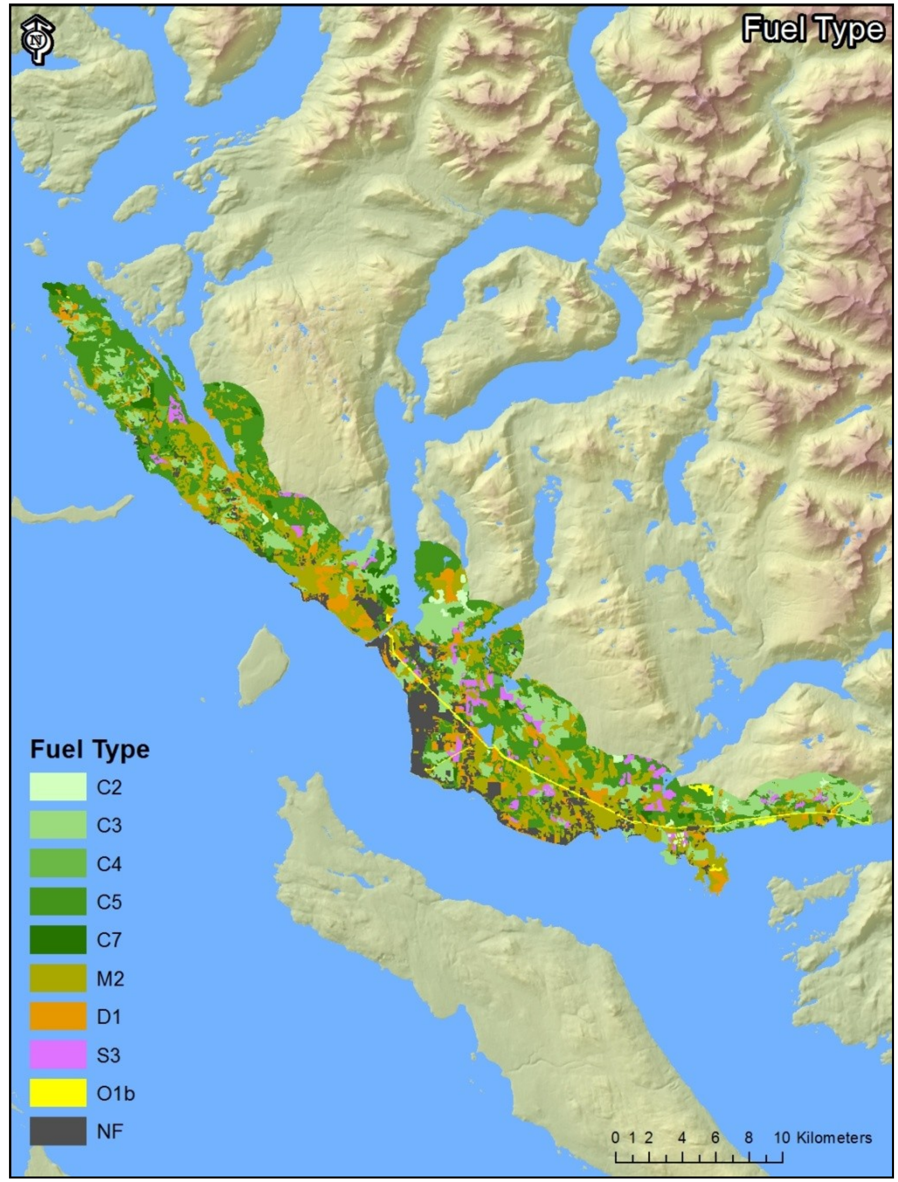
The fuel typing used to develop the Provincial Strategic Threat Analysis (PSTA) is based on inventory and information that may be outdated, therefore fuel types are generated spatially by assigning the CFFDRS fuel types based on the Vegetation Resource Inventory (VRI) data and updated with field fuel type verification. The fuel types within the study area and the composition for each fuel type are outlined in Table 1. This method uses BEC, species mix, crown closure, age, and non-forest descriptors to assign fuel type. Typically, the outputs require refinement and do not adequately describe the variation in fuels present within a given area, due to errors in VRI and adjustments required in the data. For this reason, it is important to ground-truth/verify fuel types to improve fuel type accuracy. Table 1 summarizes the fuel types by general fire behaviour and total area for the study area. In general, the fuel types considered hazardous in terms of dangerous fire behaviour and spotting (lofting burning embers) are C2, C4 and C3. An M2 fuel type can sometimes be hazardous, depending on the proportion of conifers within the forest stand. Map 3 illustrates the MFLNRO fuel types and Map 4 shows fuel types identified through VRI, orthophotos and field verification. Hazardous fuel types are shown in Map 8 and Map 12 where Priority 1 fuel types include C2 and C4, and Priority 2 is C3 fuel types. Fuel type photo examples are provided in Appendix D.

Table 1. A summary of fuel types, associated hazard and areas within the study area.

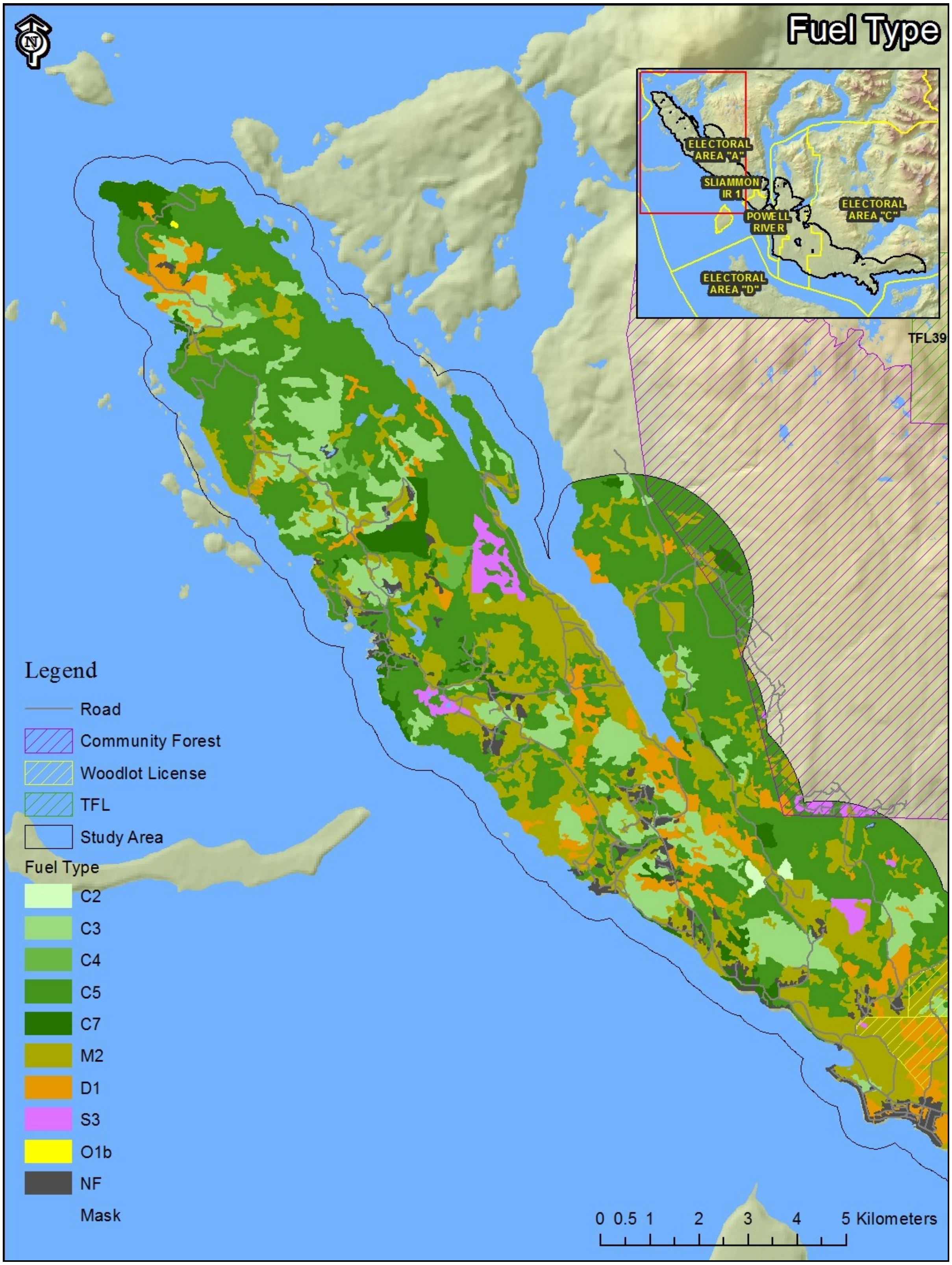
Fuel Type	Description	Wildfire Behaviour Under high Wildfire Danger Level	Area (ha)	Percent (%)
C2	Dense regeneration to pole-sapling forest with crowns almost to the ground	Almost always crown fire, high to very high fire intensity and rate of spread	247.6	0.8
C3	Fully stocked, mature forest, crowns separated from the ground	Surface and crown fire, low to very high fire intensity and rate of spread	5529.2	18.0
C4	Dense, pole-sapling forest, heavy standing dead and down, dead woody fuel, continuous vertical crown fuel continuity	Almost always crown fire, high to very high fire intensity and rate of spread	123.4	0.4
C5	Well stocked, mature forest, crowns well separated from the ground	Low to moderately fast spreading, low to moderate intensity surface fire	9916.9	32.3
C7	Open, uneven-aged forest, crowns separated from the ground except in conifer thickets, understorey of discontinuous grasses, herbs	Surface, torching, rarely crowning (slopes > 30%), moderate to high intensity and rate of spread	659.9	2.2
D1	Moderately well-stocked deciduous stands	Always a surface fire, low to moderate rate of spread and fire intensity	2352.5	7.7
M2	Moderately well-stocked mixed stand of conifers and deciduous species, low to moderate dead, down woody fuels, crowns nearly to the ground	Surface, torching and crowning, moderate to very high intensity and spread rate (depending on slope and percent conifer)	7521.8	24.5
01b/ O1b	Continuous human modified short grass;90% cured/ standing grass	Rapid spreading, low to moderate intensity surface fire/ rapid spreading, high intensity fire	468.7	1.5
S3	Coastal cedar, hemlock and Douglas-fir slash	Surface fire, high to very high fire intensity and rate of spread	1127.9	3.7
NF	Non-fuel	N/A	2715.8	8.9
		Total:	**30,663**	**100%**



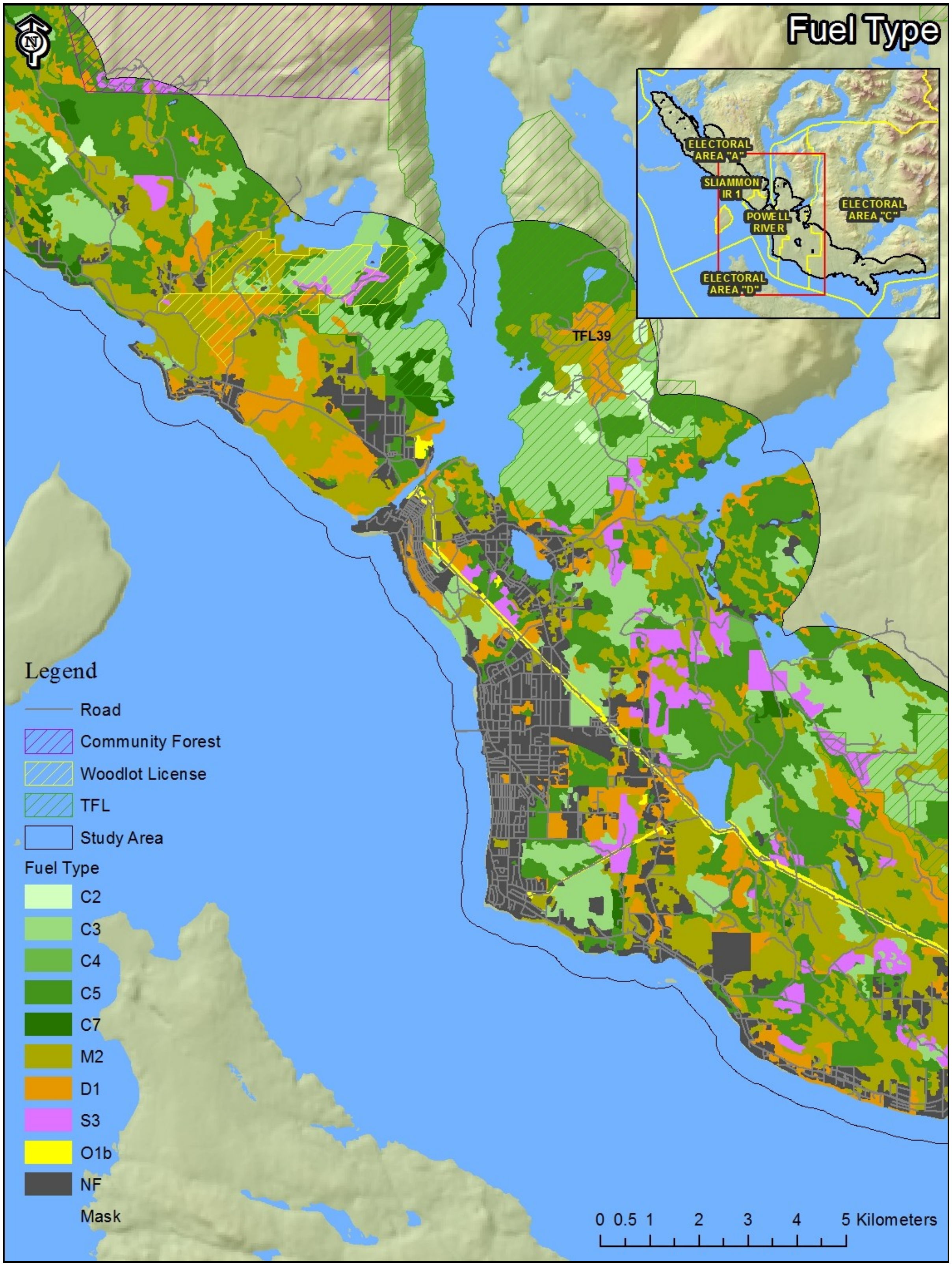
Map 3. Provincial fuel types for the study area.



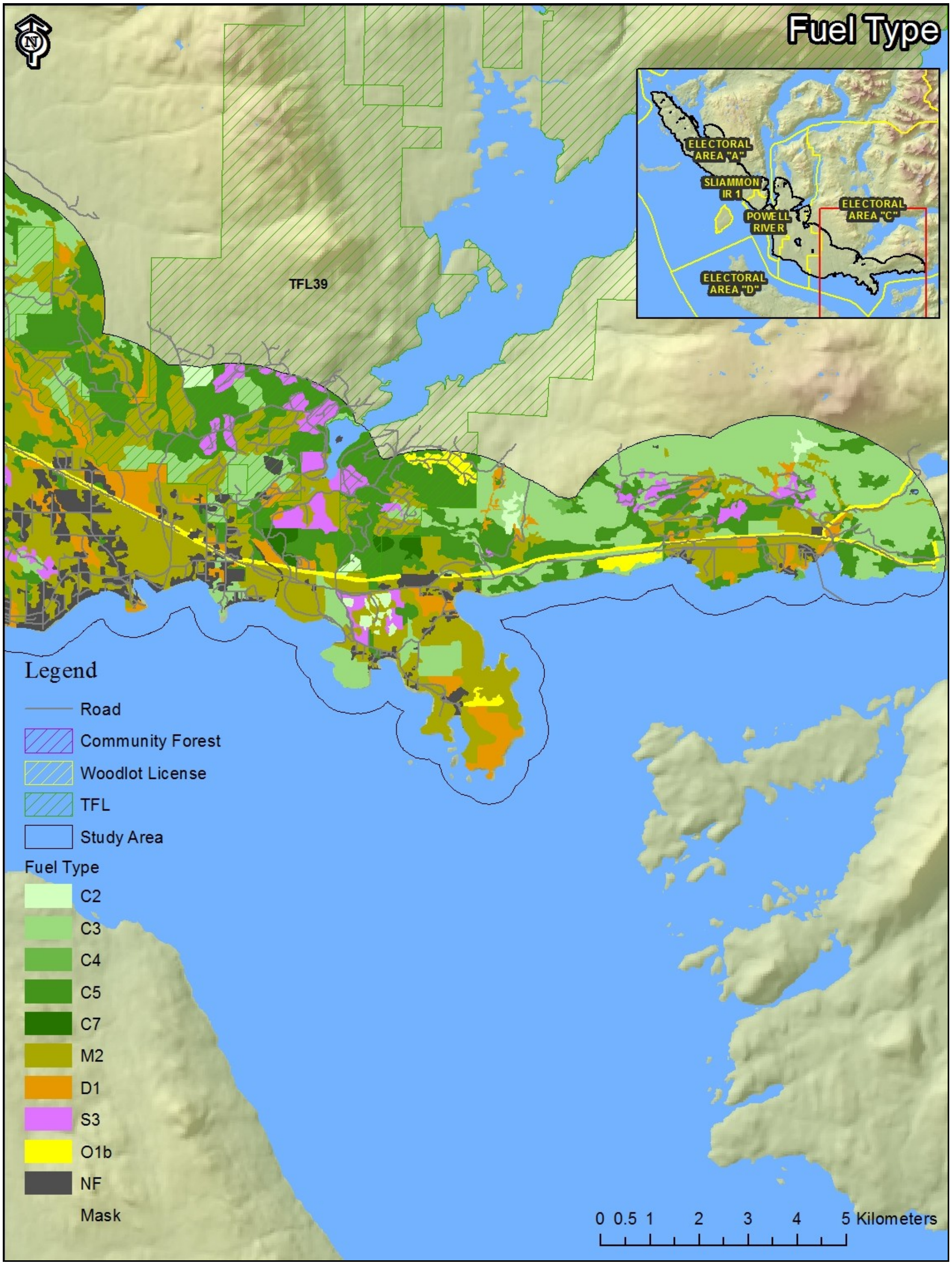
Map 4. Updated/ground-truthed fuel types for the study area.



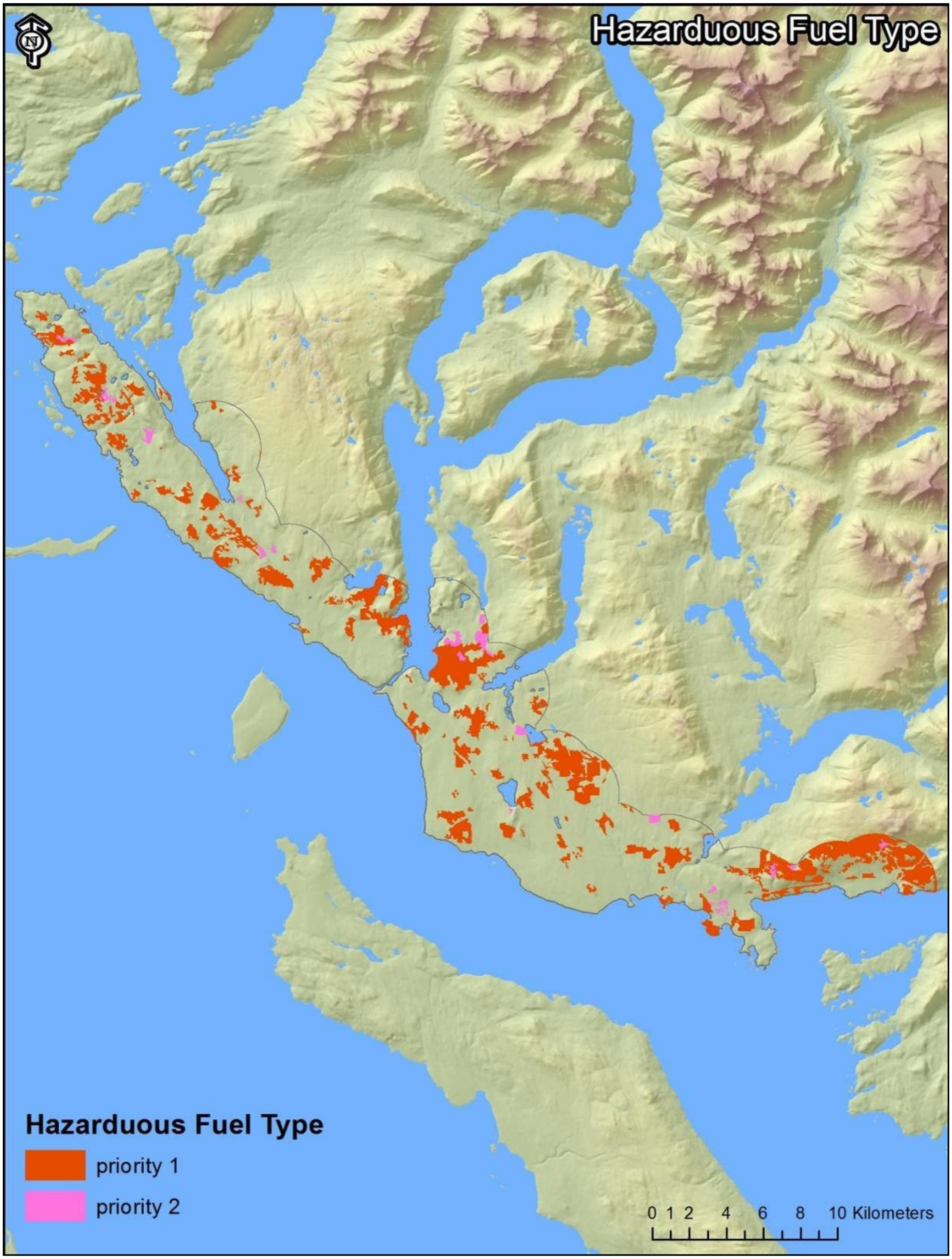
Map 5. Updated/ground-truthed fuel types of the northern portion of the study area.



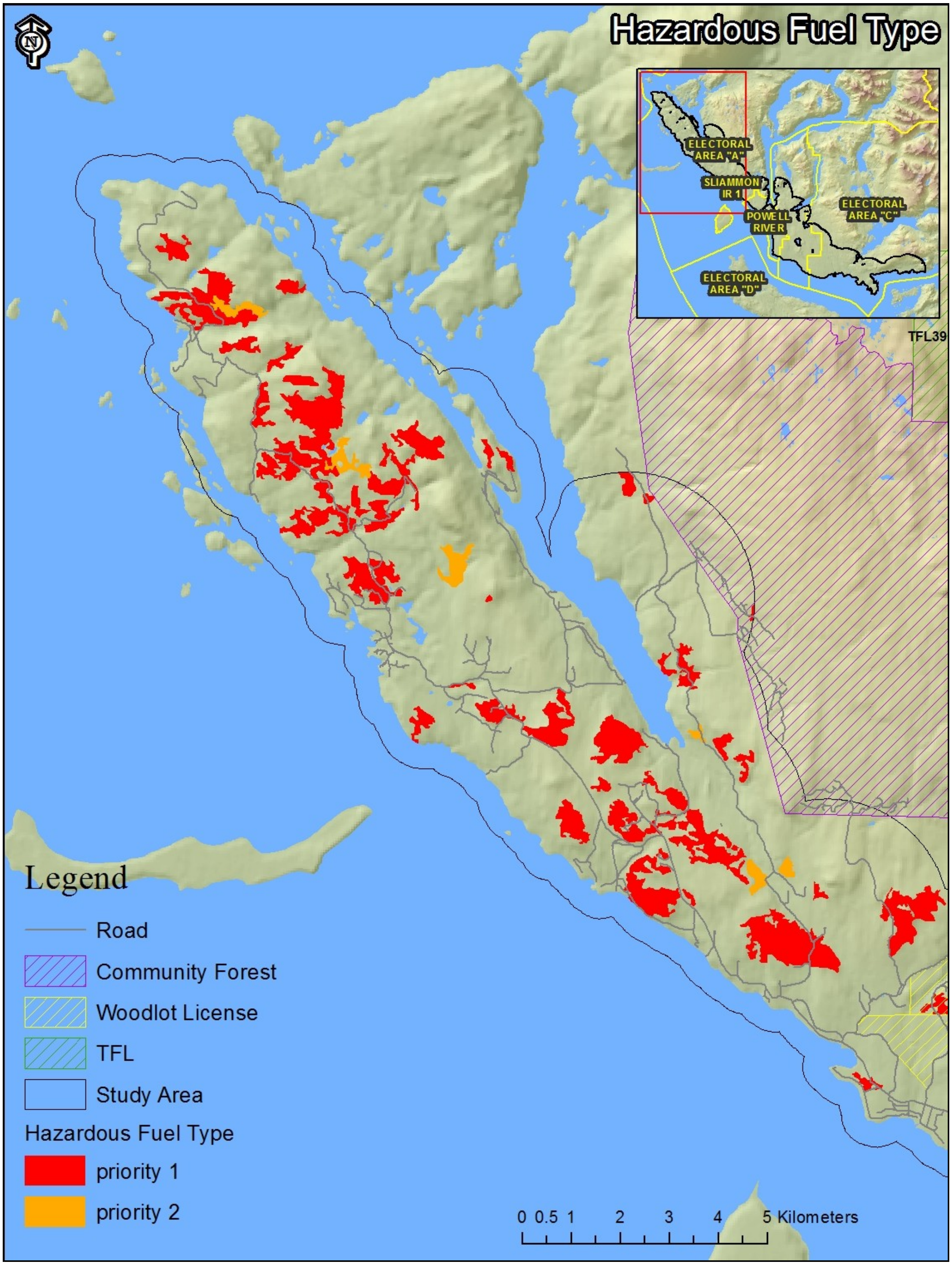
Map 6. Updated/ground-truthed fuel types of the central portion of the study area.



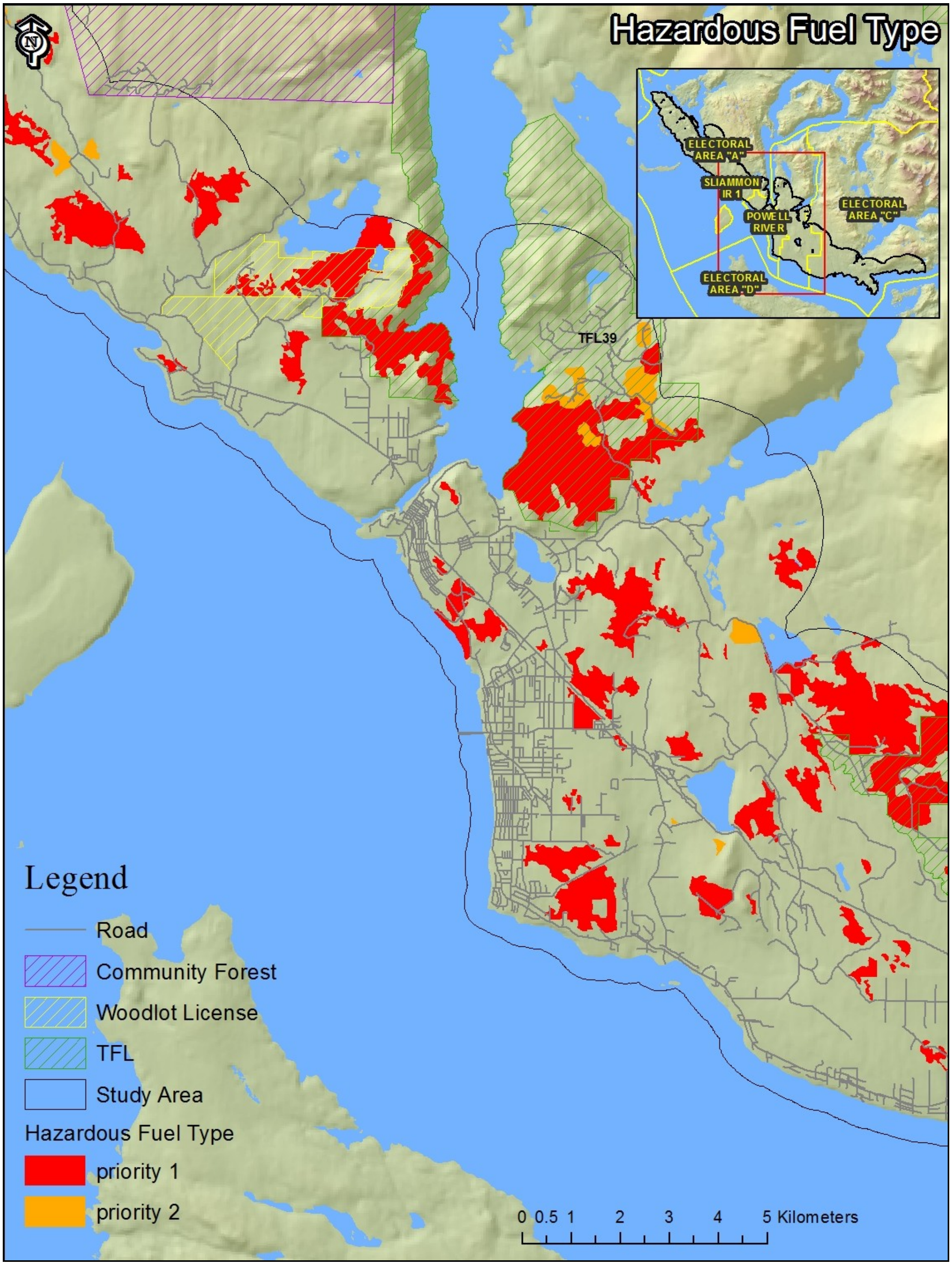
Map 7. Updated/ground-truthed fuel types of the eastern portion of the study area.



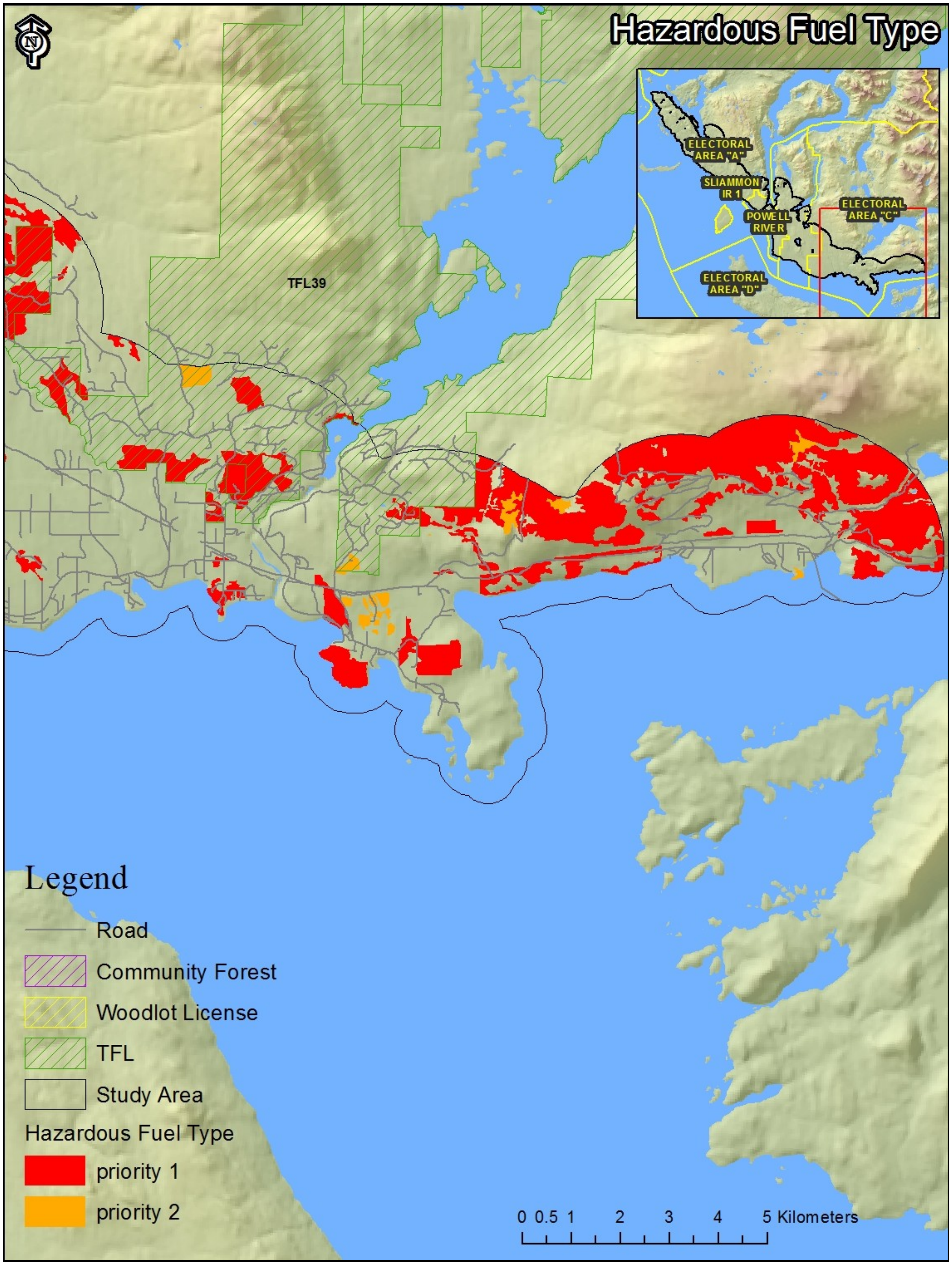
Map 8. Hazardous fuel types that occur in the study area.
Priority 1 fuels are C2 and C4 fuel types, and Priority 2 is a C3 fuel type.



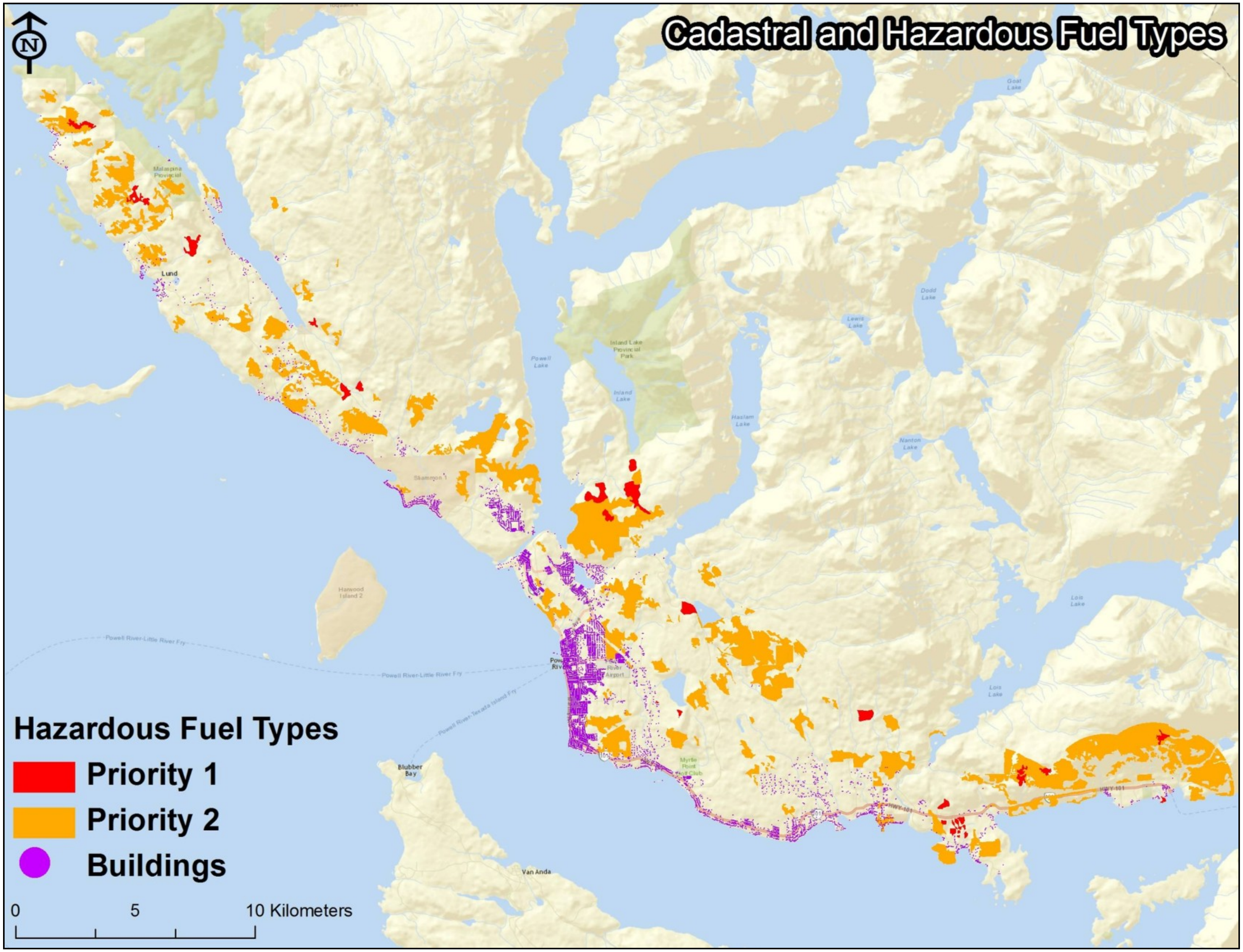
Map 9. Hazardous fuel types that occur in northern portion of the study area.



Map 10. Hazardous fuel types that occur in central portion of the study area.



Map 11. Hazardous fuel types that occur in eastern portion of the study area.



Map 12. Cadastral data overlaidwith hazardous fuel types to illustrate wildland urban interface areas of concern.

Fuel type ground truthing included data collection of approximately 340 points throughout the study area in June 2014 (Map 13 and Appendix C). At fuel typing points the following attributes were assessed: structure classification; dominant tree species; tree species type and composition (%); understorey vegetation; average age; average overstorey height; stand density; crown closure; height to live crown separation; surface fuel loading; burn difficulty; and forest floor and organic layer. A summary of the fuel type classifications is provided below. *WUI Wildfire Threat Assessments*[11] were completed in select interface and intermixed developments to support identification of high wildfire risk areas (Map 8; Table 2; Table 4). A total of 19 assessments were completed throughout the Regional District (Sarah Point, Lund, Tla'amin IR #1, City of Powell River, Saltery Bay). The *WUI Threat Assessments* do not address issues with structures; rather this system assesses the fuel hazard immediately adjacent to developments and extends into the wildland. Fuel, weather, topography and structural components are assessed.[11]

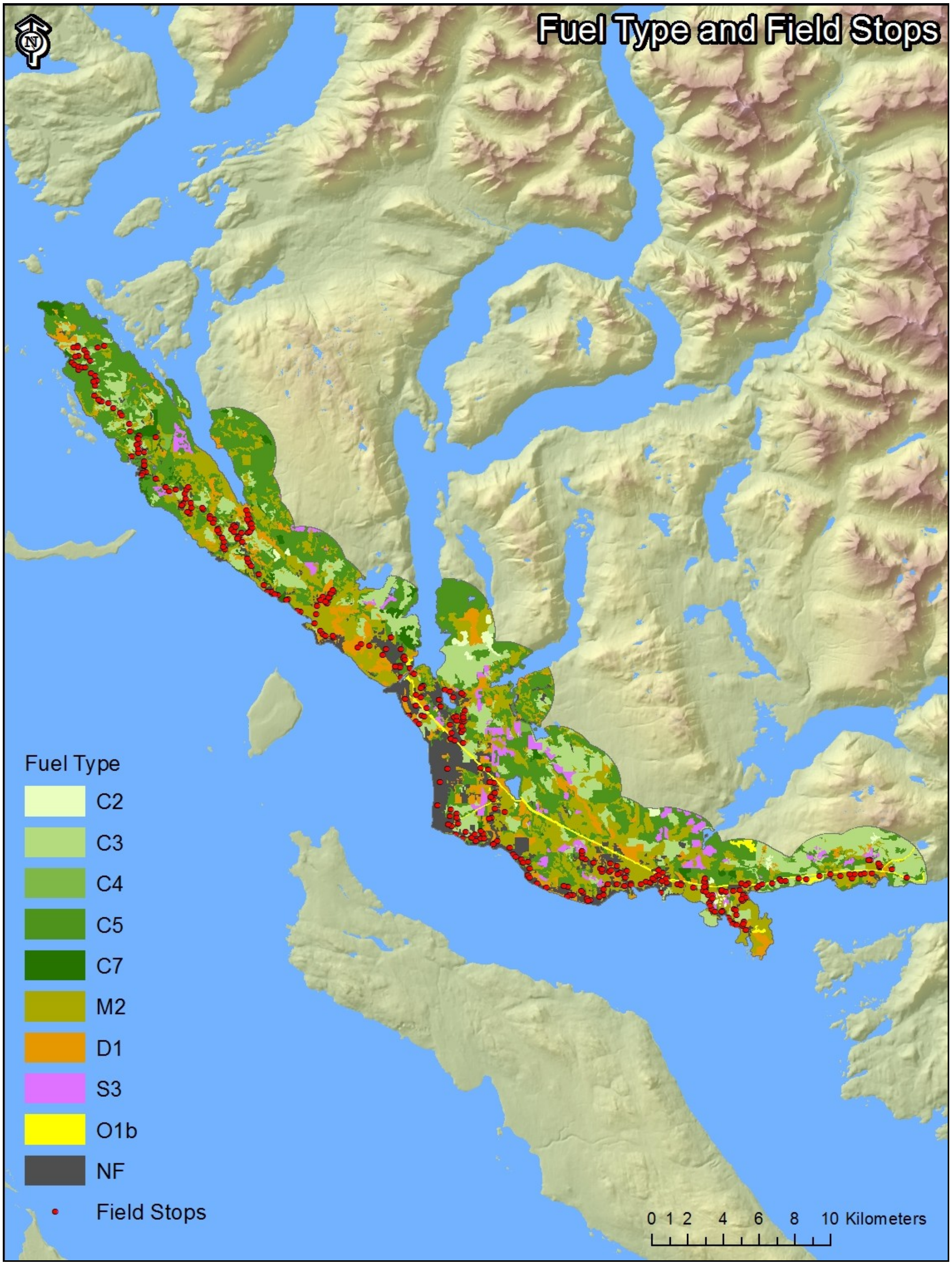
Table 2. Wildland urban interface threat worksheet summaries for the Powell River Regional District.

WUI Plot	Geographic Location	WUI Threat Worksheet Components				Wildfire Behaviour Threat Class (/240	WUI Threat Class (/55)	Total Threat Score (/295)
		Fuel	Weather	Topography	Structural			
61	Cassiar St. at Yukon Avenue	44	4	15	43	Moderate (63)	Extreme (43)	106
263	Covey Street	50	6	24	43	Moderate (80)	Extreme (43)	123
70	Padgett Road	38	4	3	43	Moderate (45)	Extreme (43)	88
159	Tanner Ave	51	6	19	43	Moderate (76)	Extreme (43)	119
212	Glenrosa Drive	26*	4	24	45	Moderate (54)	Extreme (45)	99
277	Teakerne Street	27*	2	15	40	Moderate (44)	Extreme (40)	84
278	Theodosia Avenue	56	6	31	43	Moderate (93)	Extreme (43)	136
276	North Capilano Street (Tla-amin IR #1)	52	6	19	17	Moderate (75)	Extreme (43)	118
262	Wilde Road (Tla'amin IR #1)	44	6	24	30	Moderate (74)	High (30)	104
157	Sliammon Road (Tla'amin IR #1)	43	6	16	25	Moderate (65)	Moderate (25)	90
17	Sarah Point Road (1477; South)	44	4	24	19	Moderate (72)	Moderate (19)	91
23	Lund (No. 3 Fire Hall)	30	4	24	43	Moderate (58)	Extreme (43)	101
309	Wilcox Road	40	4	24	68	Moderate (68)	Extreme (40)	108
346	Lamb Road (Saltery Bay)	51	4	18	45	Moderate (72)	Extreme (45)	117

*Where fuel values were less than 29 further assessment not required

Note: Where wildfire behaviour threat scores were less than 95, completion of the structural component was not required

[11] http://www.ubcm.ca/assets/Funding~Programs/LGPS/Current~LGPS~Programs/SWPI/Resources/swpi-WUI-WTA-Guide-(2012-Update).pdf



Map 13. Fuel type ground-truthing and field stops.

The *Wildfire Behaviour Threat Class* provides an estimate of the potential wildfire behaviour of the area. The plots completed were primarily in the moderate class. A moderate rating suggests the area is a combination of developed and undeveloped land that would support surface fires only but could threaten homes and structures. Areas with a high *Wildfire Behaviour Threat Class* rating are generally areas that are forested with continuous surface fuels that can support crown fires and include areas with steeper slopes with a southerly and/or westerly aspect.[11] No assessed areas illustrated a high *Wildfire Behaviour Threat Class* rating, with Covey Street and Theodosia Avenue illustrating the highest moderate ratings (80 and 93 respectively).

The *WUI Threat Class* is generally only assessed when the Wildfire Behaviour Threat Class is assessed as high or extreme however for this project the *WUI Threat Class* was assessed for lower ratings. Areas rated high or extreme are within close proximity (within 500 m or directly adjacent) to a community or development.[11] The combined *Wildfire Behaviour Threat Class* and *WUI Threat Class* scores provide *Total Threat Scores*.

Areas that were identified with the highest moderate *Wildfire Behaviour Threat Class* and an extreme *WUI Threat Class* were:

- Theodosia Avenue/Plot 278 (northeast of the City center; total threat score: 136; C3 fuel type); (Figure 10); and
- Covey Street/Plot 263 (northeast of the City center; total threat score: 123; C3 fuel type); (Figure 11).

The area surrounding Covey Street includes a small section of C5 and M2 stands, however they back onto an extensive stand of C3 fuels, with a gradual slope. The area surrounding Theodosia Avenue also includes continues hazardous fuels and these areas could be prioritized for fuel treatment however stands assessed as moderate threat are not currently considered for funding under the SWPI.

Figure 10. A wildland urban interface wildfire threat assessment of the Theodosia Avenue area illustrates an interface area (no inclusions) with a high wildfire behaviour threat class rating and extreme WUI threat class rating.

Figure 11. A wildland urban interface wildfire threat assessment of the Covey Street area illustrates an intermix area (> 1 structure/ha) with a high wildfire behaviour threat class rating and extreme WUI threat class rating.

The areas surrounding Tanner Ave (Plot 159; surrounded by C3 fuel type; located north of Covey Street) and Lamb Street (Plot 346; surrounded by C3 fuel type) only scored moderate in the *Wildfire Behaviour Threat Class* however they did have high *Total Threat Scores*. Based on the assessment of these areas, it is recommended that they be further reviewed for future fuel treatment programs however as highlighted above, these areas do not qualify for SWPI funding considering their moderate *Wildfire Behaviour Threat Class* ratings (Figure 12).

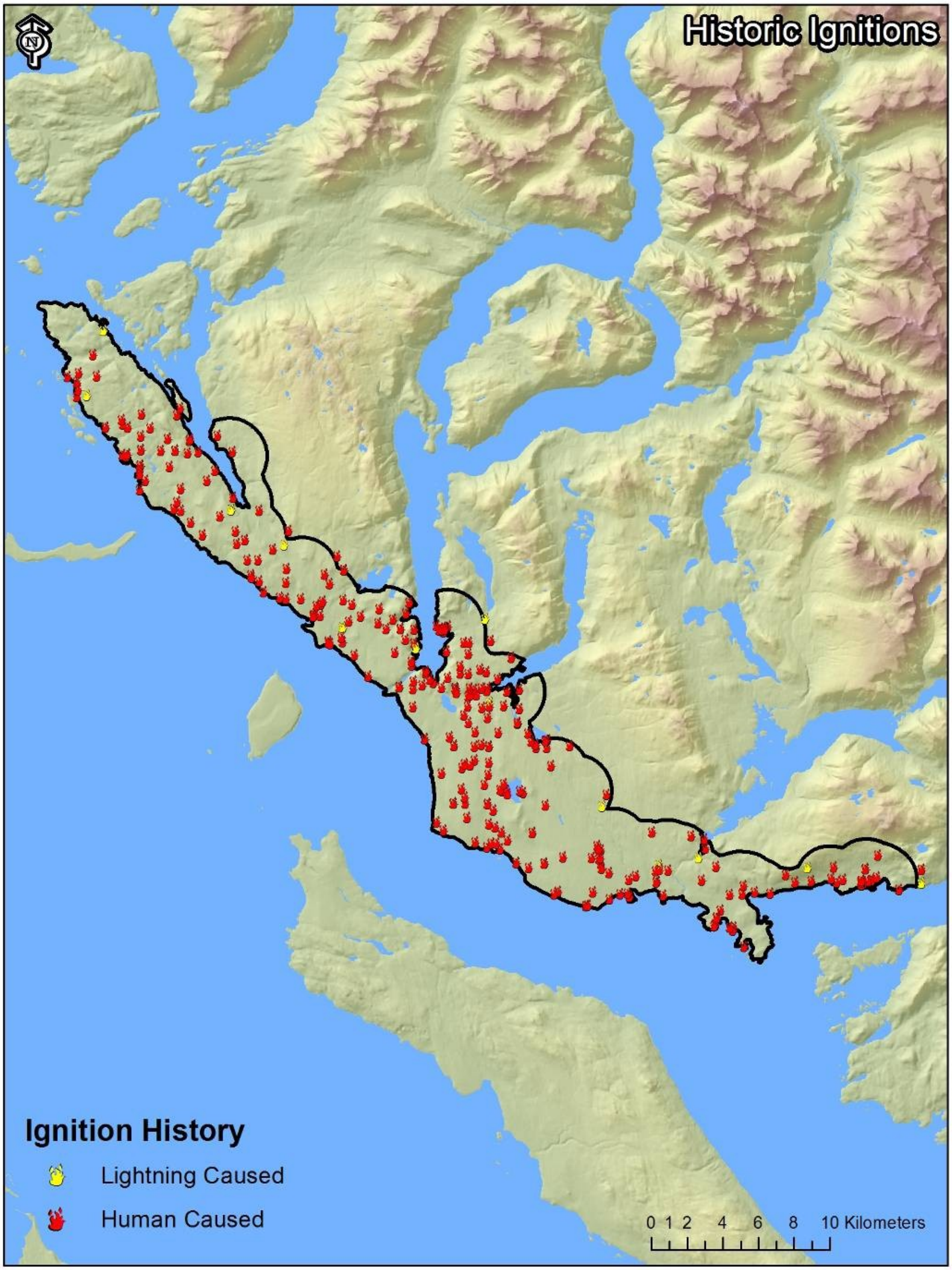
Additional areas of interest, based strictly on proximity to hazardous fuel types, that should be reviewed for fuel treatments include:

- Area north of Masters Road (north off the Sunshine Coast Hwy; C3 fuel type; Priority 2 Hazardous Fuel Type) and areas north of the Sunshine Coast Highway, between Southill Road and Rifle Range Road (includes intermix development west off Southill Road; C3 fuel type; Priority 1 Hazardous Fuel Type).
- Area east of Mackenzie Avenue (north off the Sunshine Coast Hwy/Toba Street; C3 fuel type; Priority 2 Hazardous Fuel Type; would connect with the prioritized area north of Theodosia Ave/Toba Street).

A summary of the potential treatment areas and recommended treatment types are provided below (Section 8.4).

Figure 12. A wildland urban interface wildfire threat assessment of the Lamb Street area illustrates an intermix area (> 1 structure/ha) with a moderate wildfire behaviour threat class rating and extreme WUI threat class rating.

The MFLNRO fire reporting system was used to compile a database of fires that occurred within the study area. This database provides an indication of fire history but should not be considered comprehensive. The point locations of fires are also approximate as they are based upon a grid system, not the actual location of the fire. Map 5 illustrates ignition locations of historic wildfire between 1952 and 2013. Most ignition points are attributed to human causes with a lower number of ignitions attributed to lightning. Considering the high number of human ignitions compared to lightning caused ignitions, the importance of fire education and regulation is emphasized.



Map 14. Historic ignitions.

6.3 PRINCIPLES OF FUEL MANAGEMENT

Fuel or vegetation management is a key element of the FireSmart approach. Given public concerns, vegetation management is often difficult to implement and must be carefully rationalized in an open and transparent process. Vegetation management should be strategically focused on minimizing impact while maximizing value to the community.

The decision whether or not to implement vegetation management must be evaluated against other elements of wildfire risk reduction to determine the best avenue for risk reduction. Its effectiveness also depends on the longevity of treatments (vegetation grows back), costs and the resultant effect on fire behavior.

What is fuel management?

Fuel management is the planned manipulation and/or reduction of living and dead forest fuels for land management objectives (*e.g.*, hazard reduction). It can be achieved by a number of methods, including: prescribed fire, mechanical means, and biological means.

The goal of fuel management is to lessen potential fire behavior proactively, thereby increasing the probability of successful containment and minimizing adverse impacts. More specifically, the goal is to decrease the rate of fire spread, and in turn fire size and intensity, as well as crowning and spotting potential (Alexander, 2003).

Fire Triangle:

Fire is a chemical reaction that requires fuel (carbon), oxygen and heat. These three components make up the fire triangle and if one is not present, a fire will not burn. Fuel is generally available in adequate quantities in the forest. Fuel comes from living or dead plant materials (organic matter). Trees and branches lying on the ground are a major source of fuel in a forest. Such fuel can accumulate gradually as trees in the stand die. Fuel can also build up in large amounts after catastrophic events such as insect infestations. Oxygen is present in the air. As oxygen is used up by fire it is replenished quickly by wind. Heat is needed to start and maintain a fire. Heat can be supplied by nature through lightning or people can be a source through misuse of matches, campfires, trash fires and cigarettes. Once a fire has started, it provides its own heat source as it spreads through a fuel bed capable of supporting it.

Forest Fuels:

The amount of fuel available to burn on any site is a function of biomass production and decomposition. Many of the forest ecosystems within BC have the potential to produce large amounts of vegetation biomass. Variation in the amount of biomass produced is typically a function of site productivity and climate. The disposition or removal of vegetation biomass is a function of decomposition. Decomposition is regulated by temperature and moisture. In wet maritime coastal climates, the rates of decomposition are relatively high when compared with drier cooler continental climates of the interior. Rates of decomposition can be accelerated naturally by fire and/or anthropogenic means.

A hazardous fuel type can be defined by high surface fuel loadings, high proportions of fine fuels (<1 cm) relative to larger size classes, high fuel continuity between the ground surface and overstorey tree canopies, and high stand densities. A fuel complex is defined by any combination of these attributes at the stand level and may include groupings of stands.

Surface Fuels:

Surface fuels consist of forest floor, understorey vegetation (grasses, herbs and shrubs, and small trees), and coarse woody debris that are in contact with the forest floor. Forest fuel loading is a function of natural disturbance, tree mortality and/or human related disturbance. Surface fuels typically include all combustible material lying on or immediately above the ground. Often roots and organic soils have the potential to be consumed by fire and are included in the surface fuel category.

Surface fuels that are less than 7 cm in diameter contribute to surface fire spread; these fuels often dry quickly and are ignited more easily than larger diameter fuels. Therefore, this category of fuel is the most important when considering a fuel reduction treatment. Larger surface fuels greater than 7 cm are important in the contribution to sustained burning conditions, but, when compared with smaller size classes, are often not as contiguous and are less flammable because of delayed drying and high moisture content. It should be noted that while assessment of fine fuels use 7 cm as a diameter limit, fuels up to 12 cm can contribute to fire spread and should be considered. In some cases, where these larger size classes form a contiguous surface layer, such as following a windthrow event or wildfire, they can contribute an enormous amount of fuel, which will increase fire severity and the potential for fire damage.

Aerial Fuels:

Aerial fuels include all dead and living material that is not in direct contact with the forest floor surface. The fire potential of these fuels is dependent on type, size, moisture content, and overall vertical continuity. Dead branches and bark on trees and snags (dead standing trees) are important aerial fuels. Concentrations of dead branches and foliage increase the aerial fuel bulk density and enable fire to move from tree to tree. The exception is for deciduous trees where the live leaves will not normally carry fire. Numerous species of moss, lichens, and plants hanging on trees are light and flashy aerial fuels. All of the fuels above the ground surface and below the upper forest canopy are described as ladder fuels.

Two measures that describe crown fire potential of aerial fuels are the height to live crown and crown closure (Figure 13 and Figure 14). The height to live crown describes fuel continuity between the ground surface and the lower limit of the upper tree canopy. Crown closure describes the inter-tree crown continuity and reflects how easily fire can be propagated from tree to tree. In addition to crown closure, tree density is an important measure of the distribution of aerial fuels and has significant influence on the overall crown and surface fire conditions (Figure 15). Higher stand density is associated with lower inter tree spacing, which increases overall crown continuity. While high density stands may increase the potential for fire spread in the upper canopy, a combination of high crown closure and high stand density usually results in a reduction in light levels associated with these stand types. Reduced light levels accelerate self-tree pruning, inhibit the growth of lower branches, and decrease the cover and biomass of understory vegetation.

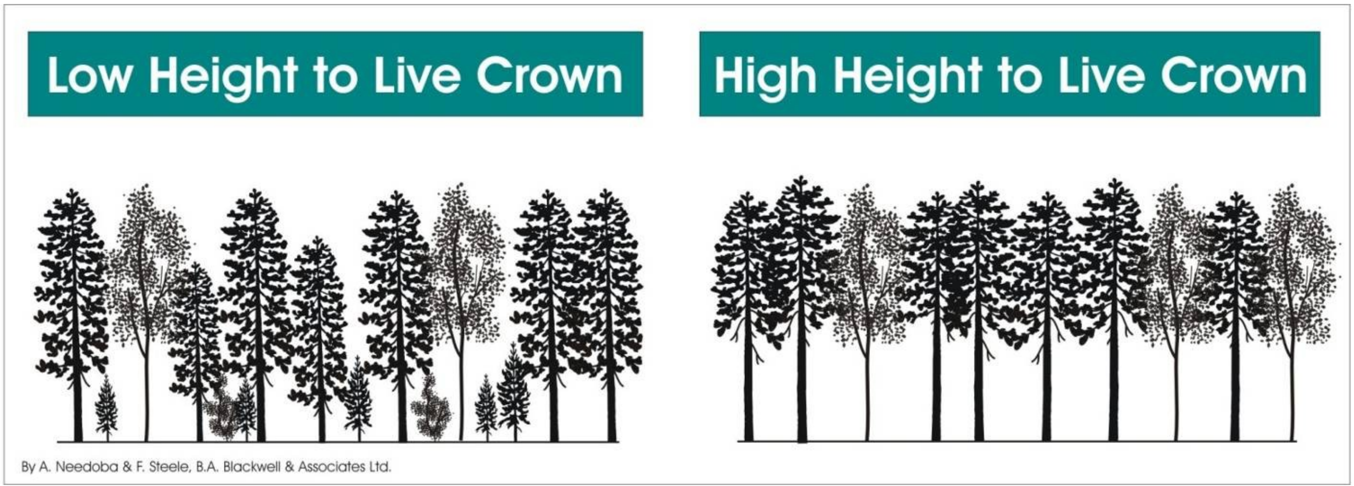


Figure 13. Comparison of stand level differences in height-to-live crown in a mixed forest.

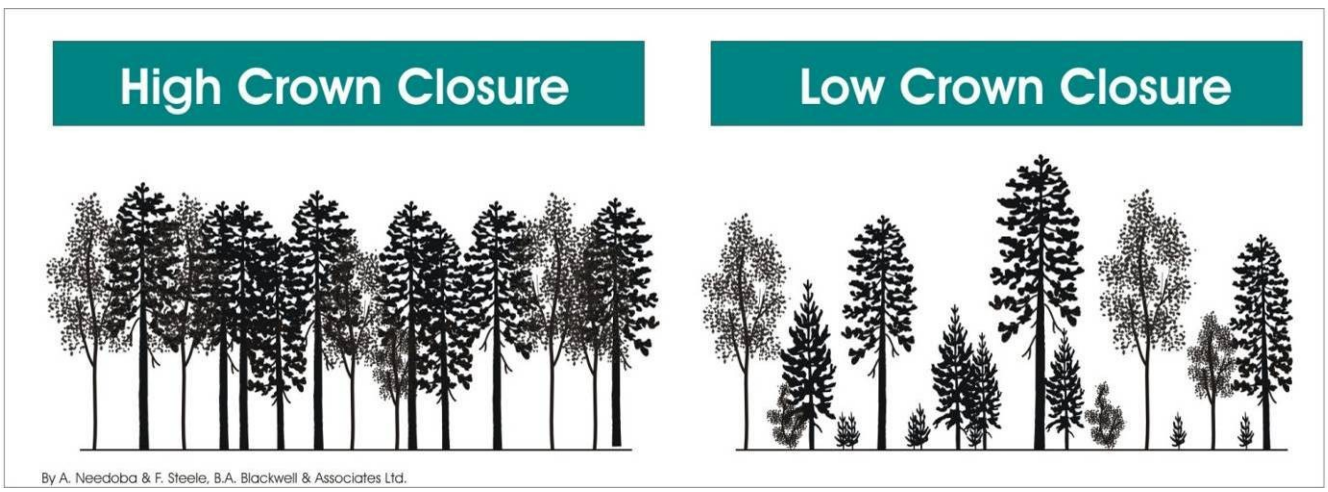


Figure 14. Comparison of stand level differences in crown closure in a mixed forest.

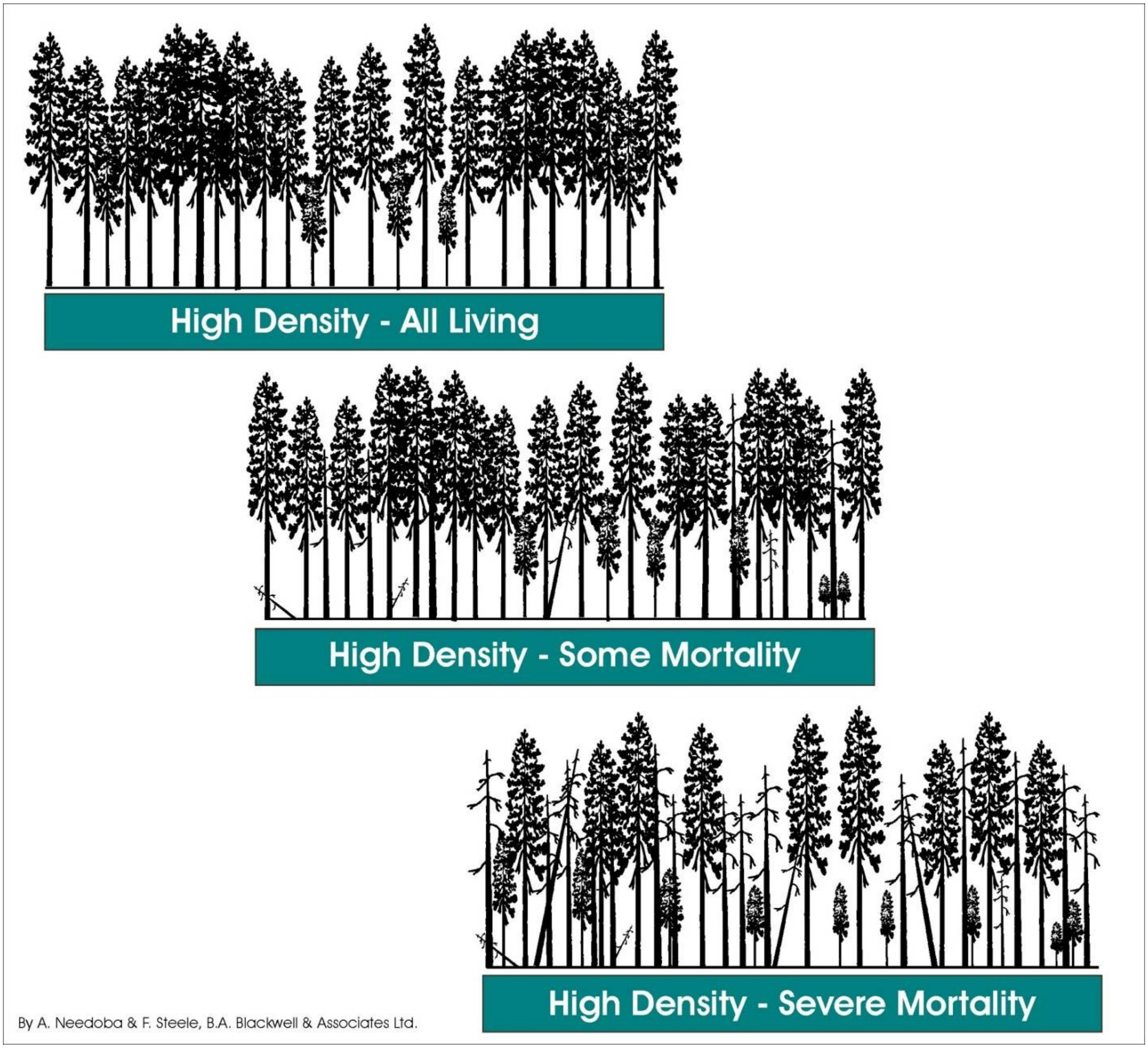


Figure 15. Comparison of stand level differences in density and mortality.

Thinning is a preferred approach to fuel treatment (Figure 16.) and offers several advantages compare to other methods:

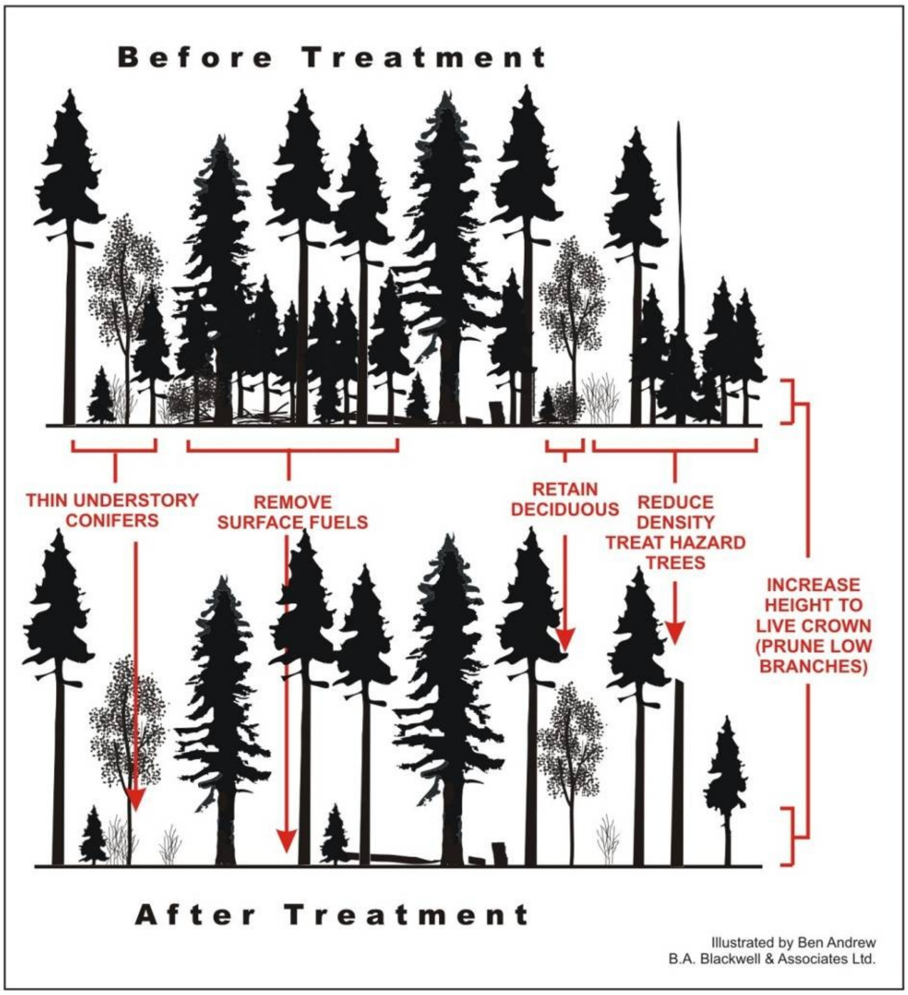
- Thinning provides the most control over stand level attributes such as species composition, vertical structure, tree density, and spatial pattern, as well as the retention of snags and coarse woody debris for maintenance of wildlife habitat and biodiversity.
- Unlike prescribed fire treatments, thinning is comparatively low risk, is not constrained to short weather windows, and can be implemented at any time.

- Thinning may provide marketable materials that can be utilized by the local economy.
- Thinning can be carried out using sensitive methods that limit soil disturbance, minimize damage to leave trees, and provide benefits to other values such as wildlife.

The main wildfire objective of thinning is to shift stands from having a high crown fire potential to having a low surface fire potential. In general, the goals of thinning are to:

- Reduce stem density below a critical threshold to minimize the potential for crown fire spread;
- Prune to increase the height to live crown to reduce the potential of surface fire spreading into tree crowns; and
- Remove slash created by spacing and pruning to minimize surface fuel loadings while still maintaining adequate woody debris to maintain ecosystem function.

Figure 16. Illustration of the principles of thinning to reduce the stand level wildfire hazard.



Fuel type, weather and topography are all primary factors that influence the spread of fires. The three most important components of weather include wind, temperature and humidity, and topography is differentiated by slope, aspect and terrain. Extending beyond the north/east side of the Highway there are forested areas with steep slopes which can have a significant influence on fire behaviour. The steepness of a slope can affect the rate and direction a fire spreads and generally fires move faster uphill than downhill, and fire will move faster on steeper slopes. This is attributed to (MFLNRO, 2014):

- *On the uphill side, the flames are closer to the fuel;*
- *The fuels become drier and ignite more quickly than if on level ground;*
- *Wind currents are normally uphill and this tends to push heat flames into new fuels;*
- *Convected heat rises along the slope causing a draft which further increases the rate of spread; and*
- *Burning embers and chunks of fuel may roll downhill into unburned fuels, increasing spread and starting new fires.*

Fuel type and slope are primary concerns related to fire spread along the forested area extending north/east off the Highway. Considering the development and activity along the Highway, in addition to the recreational (*e.g.,* Sunshine Coast Trail, ATV trails, etc) and industrial uses (*e.g.*, logging activity, etc.), there is a potential for a fire to start and rapidly move up slope in hazardous fuel types (*e.g.*, northeast end of the study area/Saltery Bay).

7.0 COMMUNITY WILDFIRE RISK PROFILE

A Wildfire Risk Management System (WRMS) was used to determine the wildfire risk profile of the study area and aimed at determining the necessary level of planning, preparedness and vegetation condition as it relates to wildfire in the Regional District. The WRMS is based on a spatial model developed in a Geographic Information System (GIS) format using ArcMap 10.1 and ArcInfo 10.1 (ESRI).

The methodology used to develop the WRMS built on the wildfire threat analysis methodology that was initially pioneered in Australia (Muller, 1993; Vodopier and Haswell, 1995) and has since been adapted for use in BC in a number of different contexts and scales (Hawkes and Beck, 1997; Blackwell *et al.*, 2003). In older applications, all fire related factors were rated equally. The WRMS developed by Blackwell and implemented for this project adopts a risk management approach to guide the quantification of separate and discrete landscape-level probability and consequence ratings. This model used a raster grid of 15 m by 15 m resolution. Individual polygons are weighted for each subcomponent (Figure 17.). Using algorithms, the subcomponents are combined to produce component weightings which are then further processed to derive probability and consequence ratings. The component weightings are standard values that have been tested and generally used when applying this model.

The content, ratings and weightings for the probability and consequence themes were developed based on professional judgment and experience from past modeling projects with similar parameters. Additionally, the project needs and values at risk relevant to the study area were reviewed prior to model implementation. Details of the component and subcomponent weightings are outlined in Figure 17. and in Appendix C.

The final spatial probability rating was derived using three major components: *Probability of Ignition, Potential Fire Behaviour* and *Suppression Capability*.

- The I*gnition* component provides a rating of the probability of wildfire occurring in a given location based on historical fire frequency. The rating was calculated as a weighted sum rating using the *Lightning Caused Fires*, *Human Caused Fires* and *Ignition Potential* subcomponents.
- The *Fire Behaviour* component provides a rating of the probability of a wildfire exhibiting extreme fire behaviour in a given location, given existing fuel types and 90th percentile weather conditions. The rating was calculated as a weighted sum rating using the *Fire Intensity, Rate of Spread* and *Crown Fraction Burned* subcomponents that are output from the FBP system.
- The *Suppression Capability* component provides a rating of the probability that a wildfire could be quickly exterminated in a given location, given existing resources. The rating was calculated as a weighted sum rating using *Constraints to Detection, Proximity to Water Sources, Air Tanker Arrival Time, Helicopter Arrival Time, Terrain Steepness* and *Proximity to Roads* subcomponents.

The final spatial consequence rating was derived from four major components that were significant within the study: *Urban Interface, Air Quality, Evacuation* and *Ecosystem Integrity.*

- The *Urban Interface* component provides a rating of the potential for a fire to pose a direct threat to people and property. The rating is calculated as a weighted sum rating using *Interface Density, Recreation Use, Drinking Water Sources,* and *Visual Quality* subcomponents.

- The *Air Quality* component provides a rating of the impact that a fire would have on regular air quality within the airshed. The impact is calculated as a weighted sum rating using *Proximity to Population Centres, Smoke Production Potential, Smoke Venting Potential,* and *Monthly Smoke Venting Potential* subcomponents.

- The *Evacuation* component provides a rating of the difficulty of evacuation from an area during a landscape-level fire event. The rating is calculated as a weighted sum rating number of structures being evacuated (*Number of Structures*) and whether evacuation can occur (*Distance to Major Roads*).

- The *Ecosystem Integrity* component provides a rating of the potential for a fire to pose a direct risk to valued ecosystem resources in the Regional District. The impact is calculated as a weighted sum rating using *Red and Blue Listed Elements* and *Old Forest* components.

At the subcomponent level, individual ratings for each raster cell were developed on a 0 – 10 scale based on existing biophysical databases (*e.g*. Vegetation Resource Inventory), professional judgment, and through the application of sub-models (*e.g*. rate of fire spread calculated using the Canadian Fire Behaviour Prediction System). References of the data sources used to derive each sub-component are summarized in Appendix C and the weightings of the subcomponents and components are also shown.

The WRMS component maps are presented in Appendix A. Fire risk is determined based on a combination of probability and consequence as per the Fire Risk Matrix (Table 3). To determine whether the probability or consequence is low, moderate, high or extreme, the value out of 10 is classified as follows:

- Low: 0 – 2.5
- Moderate: 2.6 – 5.0
- High: 5.1 – 7.5
- Extreme: 7.6 – 10.0

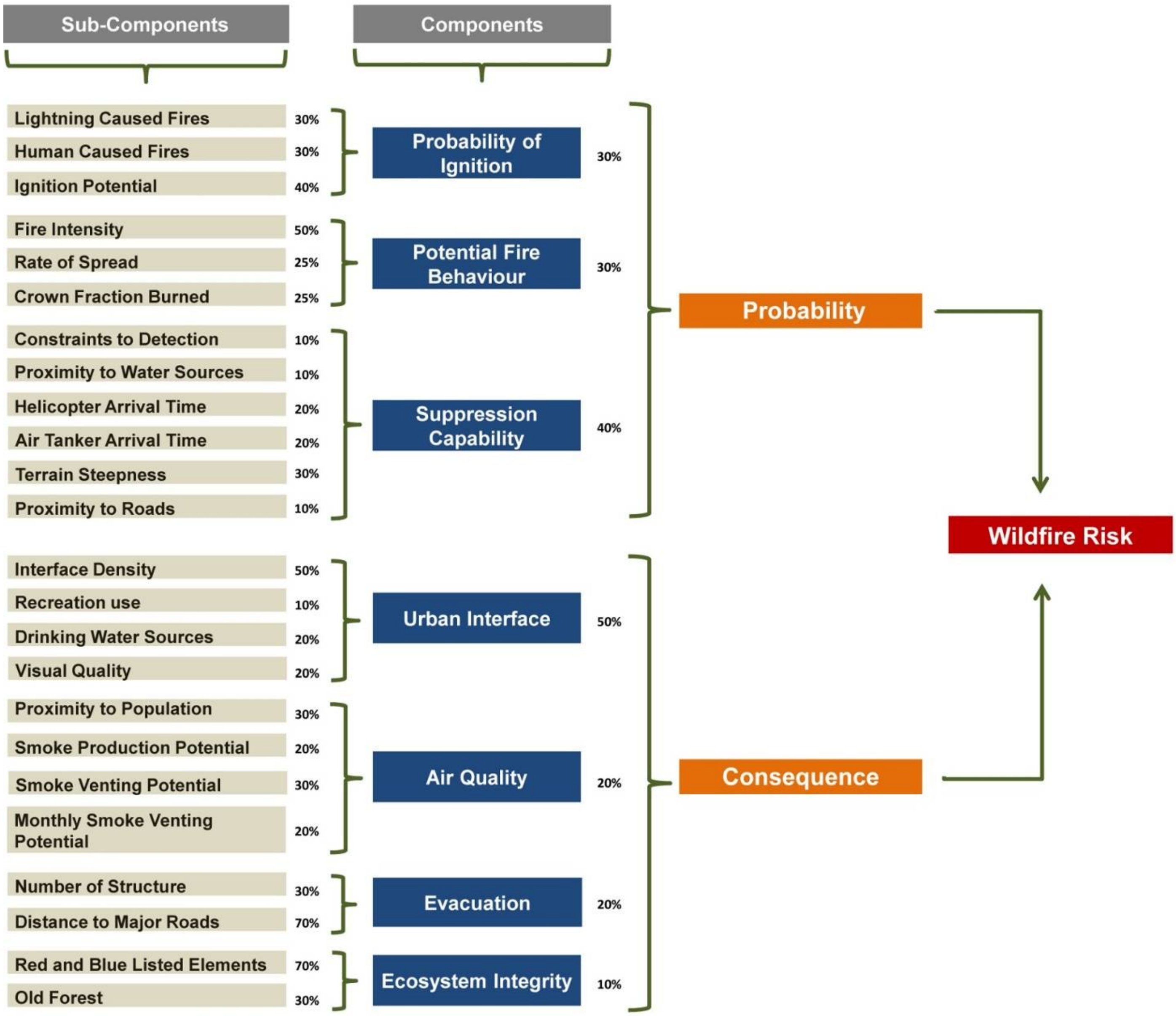


Figure 17. Wildfire Risk Management System used to calculate final probability and consequence ratings.

Table 3. Fire risk matrix (probability X consequence) used to determine risk.

		PROBABILITY>>>>			
		Low	Moderate	High	Extreme
<<<<CONSEQUENCE	Low	Low	Low	High	Moderate
	Moderate	Low	Moderate	High	High
	High	Moderate	High	High	Extreme
	Extreme	Moderate	High	Extreme	Extreme

The WRMS developed in support of this Plan identified that the probability of wildfire within the study area is predominantly moderate (Map 15). While ignition probability is high in many areas, suppression capability is very good throughout most of the Regional District. This is due to the flat terrain, access to water and availability of suppression crews and equipment. The probability of wildfire is greatest in proximity to hazardous fuel types and higher ignition potential, difficult access and where steeper slopes occur.

The consequences of a wildfire in the developed portions of the study area are high to extreme where interface density is moderate to high (Map 16). Consequence is primarily driven by the urban interface. The subcomponents for air quality, evacuation and ecosystem integrity only contribute noticeably to the definition of consequence when they overlap with urban interface values primarily due to their weightings in the model. Any one of the subcomponents (other than urban interface) occurring alone with no overlaps is not weighted high enough to increase consequence above low. This is based on the assumption that any one of these subcomponents occurring independently is not a significant driver of risk and does not warrant a risk response. However, where the subcomponents overlap, a response is warranted.

Probability and consequence are used to calculate wildfire risk (Map 17). Fire risk throughout the study area is predominantly high. Urban interface areas such as the City of Powell River rank moderate with a minor occurrence of extreme fire risk in isolated parts of the study area. Extreme fire risk is limited considering the extreme probability areas do not overlap with areas of high or extreme consequence. This is driven by the values at risk and the fuels that surround them.

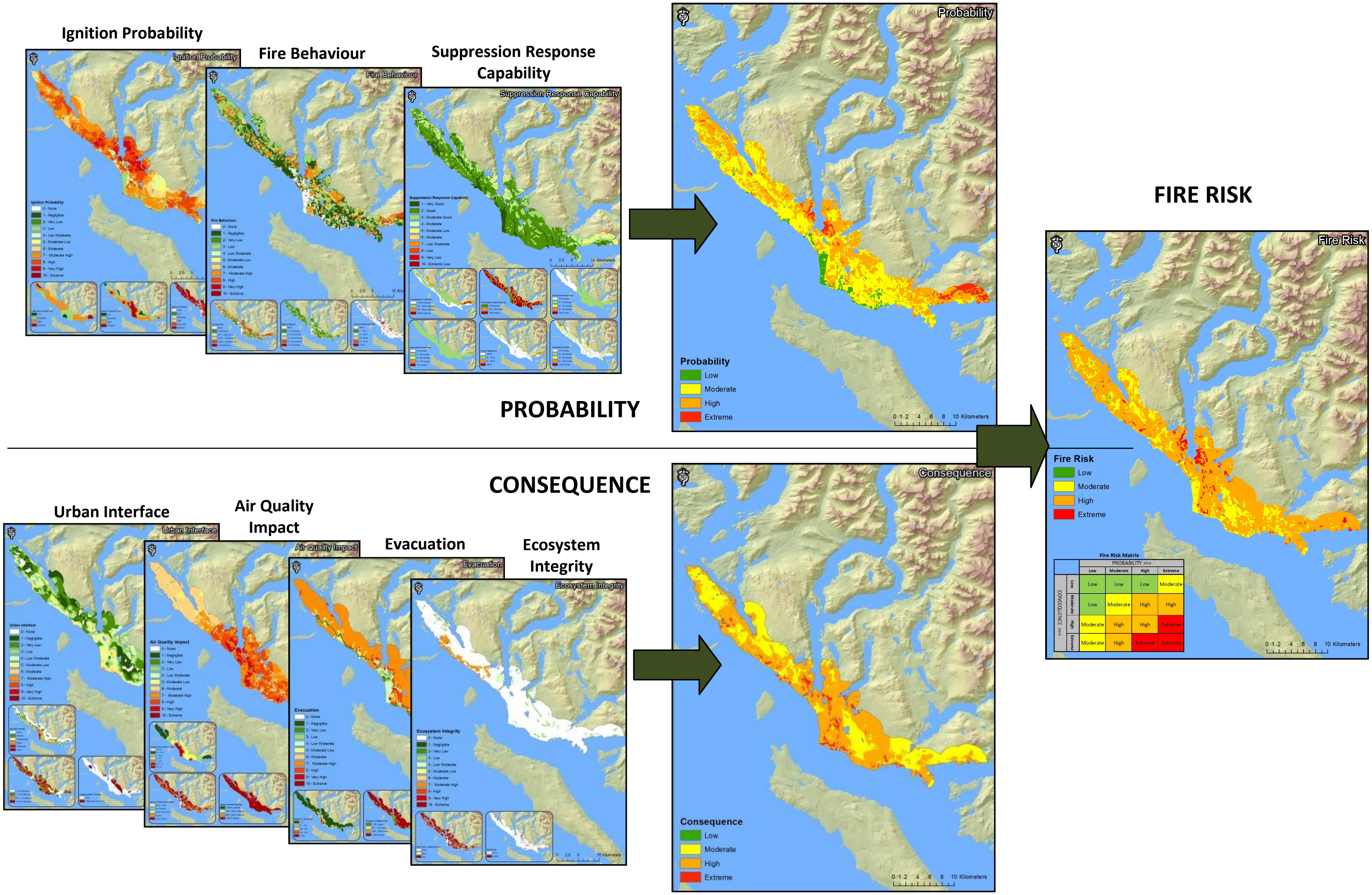
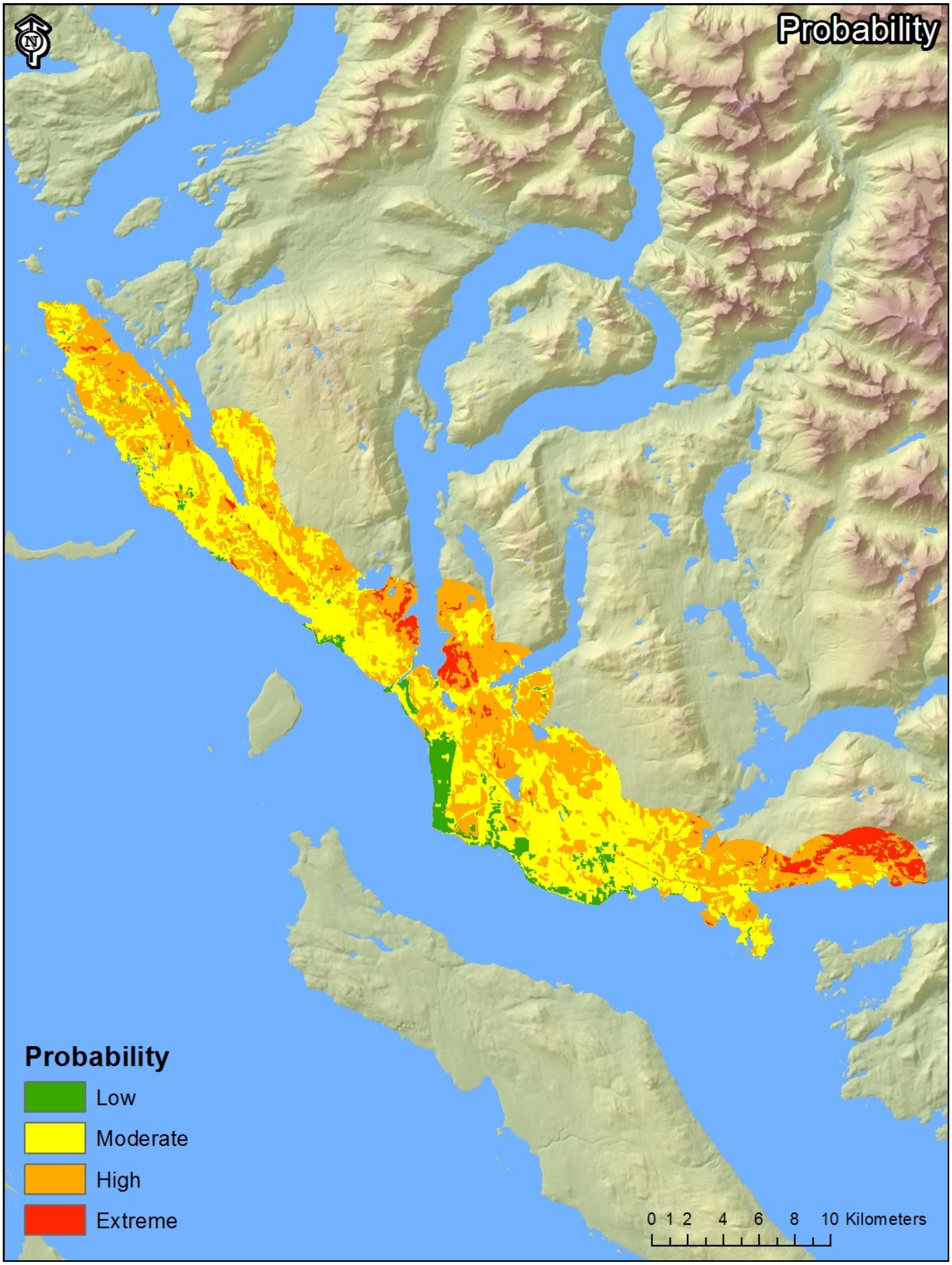
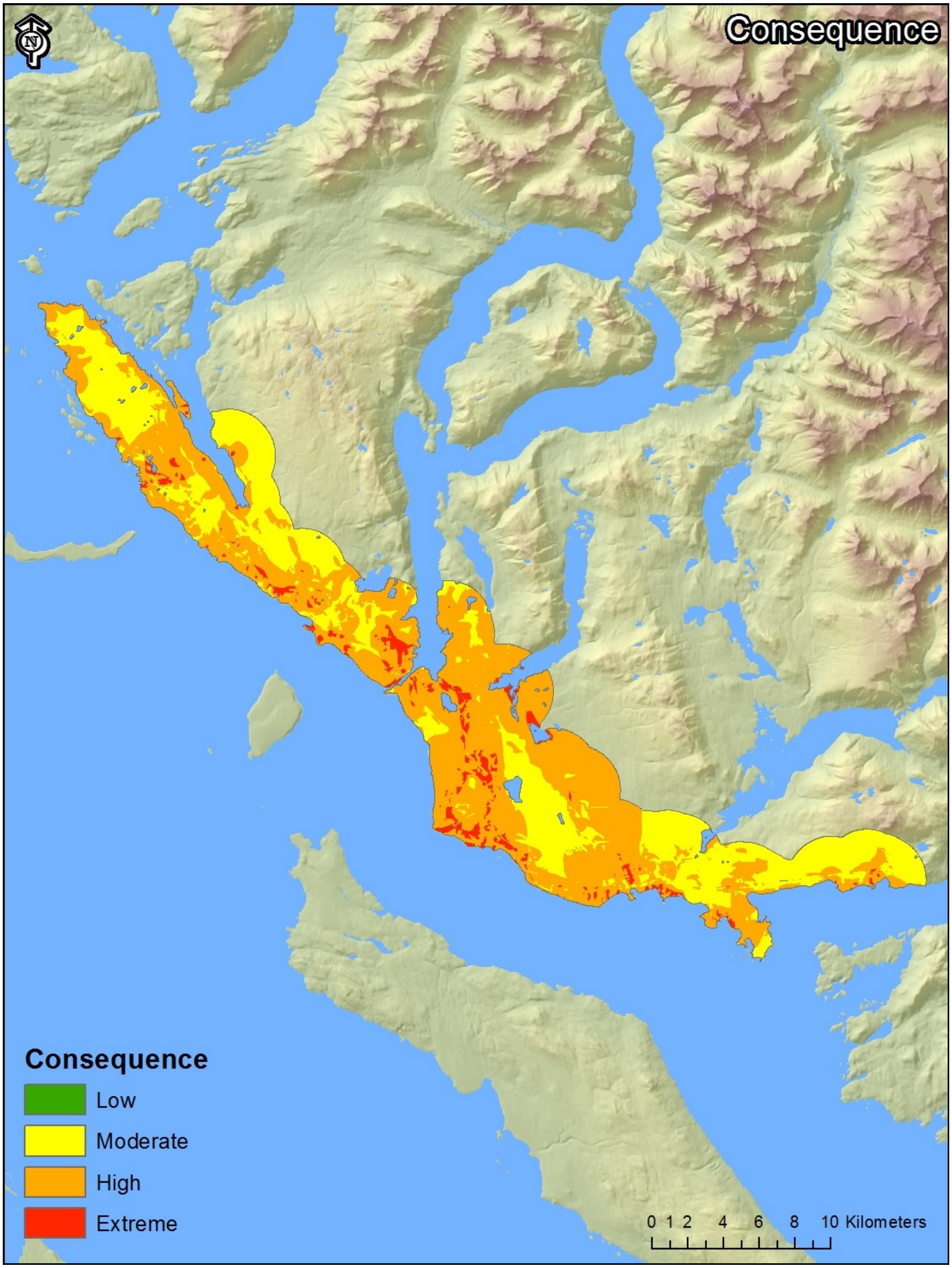


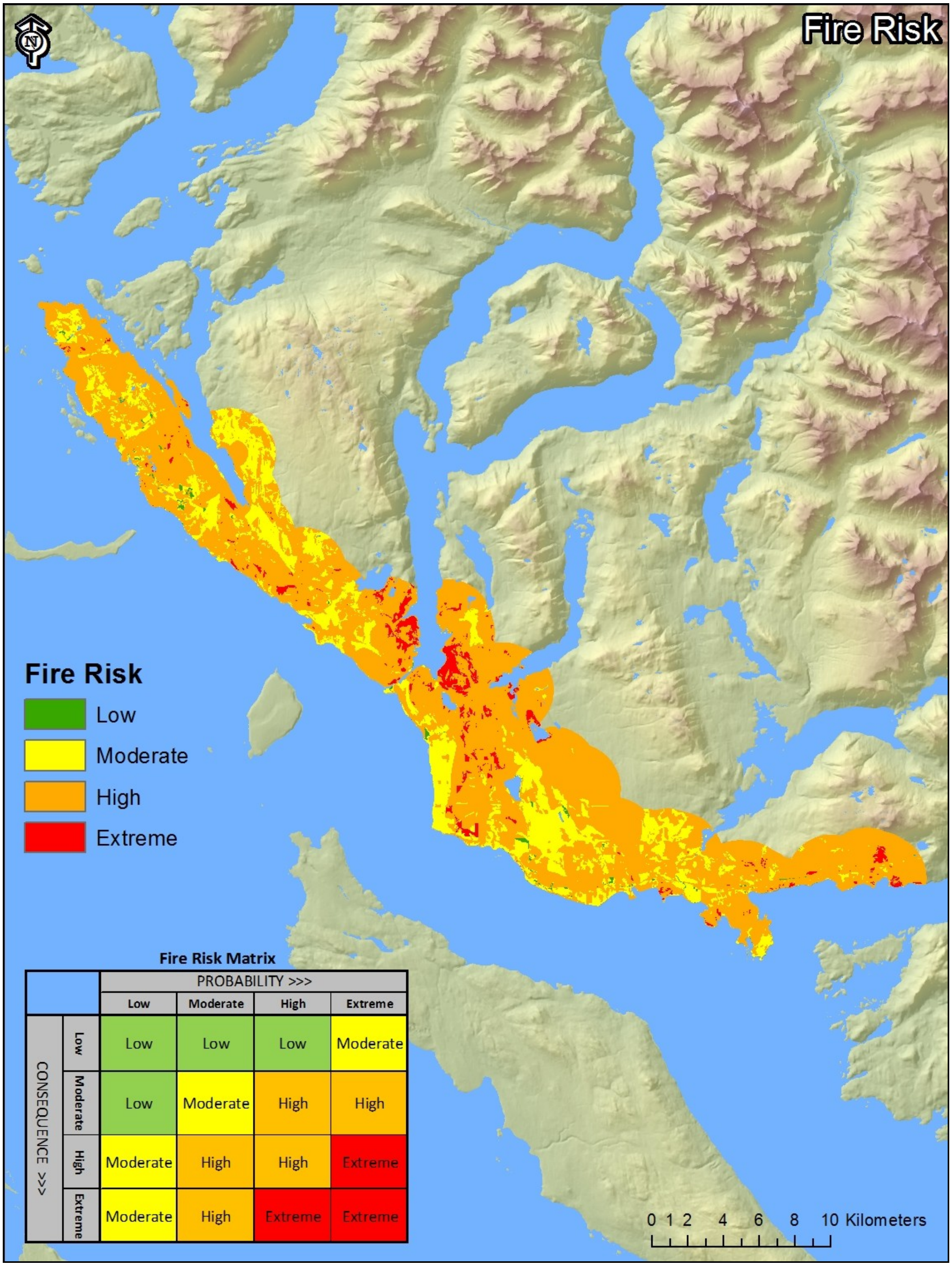
Figure 18. WRMS structure (probability x consequence = fire risk).



Map 15. Probability of wildfire occurring from the Wildfire Risk Management System.



Map 16. Consequence ratings according to the Wildfire Risk Management System.



Map 17. The overall risk of wildfire occurring in the study area according the Wildfire Risk Management System.

8.0 ACTION PLAN

The Action Plan consists of the key elements of the CWPP and provides recommendations to address each element. The elements discussed in this section include: Communication and Education; Structure Protection and Planning; Emergency Response; and Vegetation/Fuel Management.

8.1 COMMUNICATION AND EDUCATION

A community that understands the dangers that wildfires pose is important in reducing risk. Awareness and understanding will support the adoption of tools to reduce fire risk and is one of the keystones to building a FireSmart community. Without the support of the community, the efforts of public officials, fire departments, and others to reduce wildfire will be hindered. There is generally a lack of understanding about interface fire and the simple steps that can be taken to minimize risk. Public perception of fire risk is often underdeveloped due to public confidence and reliance on local and provincial fire rescue services. The communication and education objectives for the study area are:

- To provide education to residents on how to reduce fire risk on private property and to establish a sense of homeowner responsibility for reducing fire risk.
- To improve public understanding of fire risk and personal responsibility by increasing resident awareness of wildfire threat in their community.
- To increase awareness of the limitation of regional and provincial fire fighting resources to encourage proactive and self-reliant attitudes.
- To enhance the awareness of elected officials and stakeholders regarding the resources required and the risk that wildfires pose to communities.

It is important to consider that communicating effectively is the key aspect of education. Communication materials must be audience specific, and delivered in a format and through a medium that will reach the target audience. Audiences should include home and land owners, school students, local businesses, council and staff, regional directors and staff, local utilities, and forest tenure holders. Education and communication messages should be simple yet comprehensive. A basic level of background information is required to enable a solid understanding of fire risk issues and the level of complexity and detail of the message should be specific to the target audience. A complex, wordy message with technical jargon will be less effective than a simple, straight forward message.

The Regional District should consider implementing a multi-media education program that maximizes education efforts during the wildfire season. The website could be upgraded to display wildfire prevention information prominently and display fire/burning bans when they are in effect. Websites and social media are some of the most cost-effective methods of communication available. Additionally, wildfire preparedness education could be presented annually in elementary schools and the local fire departments could utilize websites and social media to communicate fire bans, wildfire prevention initiatives and other real time information.

Signs and mail-outs are also modes of communication that are proven to be effective. Signs can be used to educate homeowners on FireSmart principles. In addition to the information content, the size and placement of signs is extremely important. Signs located along the highway should be large and simple, whereas those placed around parks or residential areas can be more informative. Other great locations for informative signs are high use recreational areas, along the Hydro right-of-way, and on main Forest Service Roads. Mail-outs can be used to distribute information to the community on fire awareness/education or to publicize fire awareness events. Mail-outs can also be effective for directing information to landowners whose properties are in intermix or interface, or target areas with high hazardous fuels that present a risk to private landowners and the community.

The principle goals of a communication and education campaign identified for the study area include reducing the number of human fire ignitions and reducing fire risk on private property. To facilitate and enable effective and adequate education, the Regional District should consider employing/reinstate a Fire Prevention Officer to coordinate and manage a fire prevention education program.

Reducing Human Ignitions:

A reduction in human caused fire ignitions can be achieved through educational programs and enforcement. Human caused fire ignitions typically occur when fire weather conditions support high fire behavior. Reducing ignitions can be highly effective at reducing fire starts, especially if educational material is audience specific. Directing educational efforts to private land owners will help reduce ignitions and reduce the use of emergency resources (*e.g.*, reduce the number of fire department/MFLRNO calls for backyard burning incidences or camping/recreational related fires). Additionally, educational signage in high fire ignition areas and/or more frequent visits by Fire Departments during high and extreme fire danger times would also prove beneficial in reducing human caused ignitions.

Education of children and teenagers is an effective and long-term approach to changing beliefs and behaviours related to human caused fires and wildfire. Additionally, classroom material and exposure during elementary and high school is important to change future behavior.

Fire Risk Reduction:

Lands under private ownership which include areas with houses interspersed in the forest (intermix) and interface areas, can make large areas either financially unfeasible to treat or they are untreatable due to ownership issues. It is important for homeowners to understand the measures they can take to reduce the risk of wildfire on and around their property. In particular, landowners with lots that are forested or support hazardous fuels that are located in key interface areas need to be made aware of their responsibility to reduce hazardous fuels on their properties to help safeguard the community. A combination of education and appropriate bylaws, or development permit areas can provide the information and incentive for owners to better protect private property and reduce the community's risk. Additionally, to provide homeowners with a working example of what a FireSmart property looks like and how it can be achieved the Regional District should consider developing a demonstration FireSmart property in a central location. Potential areas for consideration include the C3 fuel type surrounding Theodosia Avenue (within the City), or off Tanner Avenue and Covey Street (located south of

Cranberry Lake). Demonstration areas have been used in other communities in BC and have proven beneficial in providing residence with an interactive example of how FireSmart principles can be employed on private property.

Choices in exterior building materials, setbacks from forest edges, and landscaping choices are all measures that homeowners can employ to reduce fire risk. Forested parcels of land interspersed in communities can create hazardous fuel conditions that put the whole community at risk. Currently there are no programs in the Regional District that will assist homeowners in upgrading the fire resistance of their homes, reducing hazardous fuels, or applying FireSmart principles on their property. The best approach to reducing risk in these key areas is through regulation and education. FireSmart material is readily available and simple for municipalities to disseminate. It provides concise and easy-to-use guidance that allows homeowners to evaluate their homes and take measures to reduce fire risk. However, the information needs to be supported by locally relevant information that illustrates the vulnerability of the individual houses or specific areas to wildfire.

Detailing the limitation of the local Fire Departments to action fires is important. Most individuals do not realize that a small department is limited to fighting one house fire at a time. Homeowners should be made aware that during a wildfire, suppression crews will assess houses to determine which homes they will prioritize for triage (protection measures to help save structures). Part of the triage process is to determine how defensible a house is and how safe it is for suppression crews to operate. Houses with a low chance of being saved or that are unsafe for crews to access are less likely to receive triage than houses with good setbacks, access, and fire resistant building materials and design. Annually, fire departments and municipal staff should consider conducting FireSmart assessments of houses with residents, and the WMB could provide support where possible.

Bringing organizations together to address wildfire issues that overlap physical, jurisdictional or organizational boundaries is a good way to help develop interagency mechanisms to reduce wildfire risk and foster relationships that can be important during a wildfire event. Additionally, by engaging multiple stakeholders, the gained information and opinion can be used to find unique and local solutions to reduce wildfire. The establishment of a Wildfire Committee could be an option to invite engagement and coordination. A Wildfire Committee could include representatives from local fire departments, the Regional District, City of Powell River, each Electoral Area, MFLNRO WMB, and key stakeholders such as BC Hydro and forest licensees.

Communication and Education			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: Improve public understanding of fire risk and personal responsibility by increasing resident awareness of wildfire threat in their community.			
1	High	• Employ a Fire Prevention Officer to deliver education programs and coordinate fire prevention information throughout the Regional District.	~$75,000 annually
2	High	• Provide FireSmart education materials to the point of issuing building permits through the support of the City of Powell River so that people know the fire hazard where they are building and what they can do to reduce those hazards.	See recommendation #1 + maintenance
3	High	• Develop a demonstration FireSmart property in a central location in the Regional District to provide homeowners with a working example of what a FireSmart home and property looks like and how it can be achieved.	See recommendation #1
4	High	• Upgrade the Regional District website to display or link wildfire prevention information and display real time information on fire bans and high fire danger, and provide a link to FireSmart information.	See recommendation #1 + maintenance
5	High	• Utilize social media (*e.g.*, Facebook, Twitter, etc.) to communicate fire bans, high fire danger days, wildfire prevention initiatives and other real time information.	Within current operating costs
6	High	• Review and update wildfire preparedness education in elementary and high schools.	See recommendation #1 + maintenance
7	Moderate	• Fire Departments should rate houses on suitability for triage and share rating information and recommendations with homeowners in high hazard areas.	Within current operating costs
8	Moderate	• Post information from the CWPP on the Regional District website showing areas with hazardous fuel complexes.	Within current operating costs
9	Low	• Install educational signage in high fire ignition areas.	$5,000 + maintenance
10	Low	• Encourage more frequent visits by Fire Departments during high and extreme fire danger times to high ignition areas.	See recommendation #1 + maintenance
Objective: Enhance the awareness of elected officials and stakeholders regarding the resources required and the risk that wildfires pose to communities.			
11	High	• Establish a Wildfire Suppression Group (Regional District, Fire Departments, MFLNRO WMB, BC Hydro and forest operator representatives) to identify wildfire related issues within the Regional District, resource deficiencies, and to allow for a coordinated approach to wildfire mitigation. This committee can be organized by the Fire Prevention Officer.	See recommendation #1

8.2 STRUCTURE PROTECTION AND PLANNING

Building a FireSmart community will help reduce losses and impacts related to a wildfire. For this Plan, two classes of structures were considered: critical infrastructure; and residential or commercial infrastructure. Critical infrastructure is distinct as it provides important services that may be required during a wildfire event or may require additional considerations or protection. FireSmart principles are important when reducing wildfire risk to both classes of structure and are reflected in the outlined recommendations. The structure protection objectives for the study area are:

- To protect homes/structures and critical infrastructure.
- To develop policy tools to adopt FireSmart standards over the next five years and to encourage private homeowners to voluntarily adopt FireSmart on their properties.
- To improve public understanding of fire risk and personal responsibility.

There are two main avenues for implementing FireSmart:

1. Change the vegetation type, density, and setback from the structure; and
2. Change the structure to reduce vulnerability to fire and reduce the potential for fire to spread to or from a structure.

Critical infrastructure is important to consider when planning for a wildfire event. The use of construction materials, building design and landscaping that apply to residential and commercial structures must also be considered for critical infrastructure. Additionally, setbacks from vegetation should be compliant with FireSmart recommendations.

BC Hydro supplies electricity throughout the study area and the Hydro right-of-ways (ROWs) can be high potential for ignition and power loss. The Regional District needs to ensure clear lines of communication with BC Hydro to ensure that annual pre-fire season assessments of ROWs occur where required (*e.g*., areas of dense Scotch broom and/or fuel accumulations).

Homes and subdivisions within the Regional District vary in terms of whether they meet FireSmart standards for construction or vegetation around homes. Some homes within the study area have rated roofs however the majority of the homes do not have rated roofs and are often very close to flammable vegetation or constructed with fire vulnerable siding. Fire research indicates that roofing, adjacent to burnable materials and landscaping play the greatest role in structure ignitability. There is currently no wildfire vulnerability standard for building materials used in the Regional District. In areas of concern, changing Regional District policy is an avenue to improve FireSmart conditions and suppression access for interface and intermix areas. This can be achieved by implementing Development Permit Area bylaws, however these types of bylaws would need to be developed and implemented beyond the City of Powell River and include the higher risk interface and intermix areas throughout the Regional District. This will require support from within the City with respect to permitting and implementation.

Additionally, many homes in interface and intermix areas store combustible materials within 10 m of residences and this is a significant fire issue. Woodpiles or other flammable materials adjacent to homes provide fuel and an ignitable surface for embers.

Structure Protection and Planning			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: Improve the FireSmart conditions and suppression access for interface areas to meet NFPA 1142 (Water Supplies for Suburban and Rural Fire Fighting) and 1144 (Protection of Life from Wildfire) standards.			
12	High	• Encourage residents to adopt FireSmart principles on their property.	See recommendation #1 + maintenance
13	High	• Review all critical infrastructure and prioritize upgrades where required.	Within current operating costs + upgrade costs
14	High	• New subdivisions should be developed with access suitable (2-way in and out; adequate width and turnaround for emergency vehicles) for evacuation and the movement of emergency response equipment.	Within current operating costs
15	Moderate	• Development and implementation of a Wildfire Hazard Development Permit Area that requires FireSmart building practices in moderate and high hazard areas.	$30,000 (one time cost) + maintenance
16	Moderate	• Create a spatial database of all critical infrastructure and review all critical infrastructure for fire vulnerability to help reduce structure loss.	$5,000 (one time cost) + maintenance
Objective: BC Hydro completes annual pre-fire season assessments and mitigation of right-of-ways to reduce the potential for ignition and power loss.			
17	High	• Engage with BC Hydro to coordinate and support annual assessments and mitigation of fire hazards along BC Hydro right-of-ways.	See recommendation #1

8.3 EMERGENCY RESPONSE

The Regional District Fire Departments (City of Powell River, Malaspina, Northside and Tla'amin) are responsible for first response in their fire protection areas. The majority of department training focuses on structural fire fighting and includes annual cross-training with the MFLNRO fire base. The Regional District and MFLNRO work together closely to support wildland emergency responses throughout the District. The emergency response objectives for the study area are:

- To improve emergency access and evacuation ease throughout the study area.
- To maintain communication and cooperation among fire departments, the Regional District and the MFLNRO WMB.
- To develop and implement a Regional District-wide evacuation plan in the next two years.

The greatest challenges facing the Regional District Fire Departments include staffing and equipment:

- Currently the City of Powell River Fire Department does not have a fully staffed (four person) truck (deficient by 2 career fire fighters on each call/truck as outlined by NFPA 1701) and the Department does not have a Fire Prevention Officer (as addressed in section 7.1).
- The Malaspina Fire Department operates with on-call staff. Malaspina is currently under review for a replacement fire hall. Challenges for Malaspina include a shortage of hydrants throughout their service area.
- The Northside Fire Department operates with on-call staff. The Northside fire protection area includes resource roads which require an interface truck. The Department has decommissioned their interface truck and will need a replacement to ensure service for their protection area.
- The Tla'amin Fire Department operates with limited on-call, trained staff. Currently the Department is running with one trained member. This Department requires additional on-call staff and all staff should receive training.

Training and equipment can be improved for each department and it was identified that the Regional District could benefit from a Regional District Sprinkler System that could be housed and operated through the City of Powell River Fire Department.

One of the most challenging situations facing emergency response during a wildfire event is evacuation of the populace. Evacuation can be complicated by smoke, fire, traffic accidents, or congestion in key areas. Access throughout the study area is variable. Most areas have 1-way in and out access, and many roads in the interface and intermix areas are narrow and difficult for emergency vehicles to access. Sarah Point is a good example of a single egress route on an unpaved road, through hazardous fuels. Emergency access and evacuation planning has not been formalized throughout the study area. Although access and egress planning is limited considering the constraints of the road network and isolation of the Regional District; however, the Regional District should consider building an Evacuation Plan to:

- Map and identify safe zones, marshalling points and aerial evacuation locations.
- Plan traffic control and accident management.
- Identify volunteers that can assist during and/or after evacuation. This would include door-to-door notification
- Create an education/communication strategy to deliver this information to residents.

Additionally, many homes lack visible addresses, have gated access and many homes could benefit from triage assessments, to ensure accessibility and safety of fire fighters. Fire triage is an important tool used by fire suppression crews to improve the potential for structures to survive a fire event. The process involves determining which houses have the greatest likelihood of surviving a wildfire and therefore should be prioritized for additional protective measures such as setting sprinklers or spraying retardant. Triage assessments are dependent on five main factors which include: fire fighter safety, structure design and material, fuels around the structure, fire behavior and available resources. Houses that follow FireSmart guidelines have a better probability of being prioritized for protection. Conducting assessments of housing in the WUI prior to a fire can assist in suppression efforts. The assessments can also be used to educate homeowners as to what protection they might receive during a fire event and what changes they can make to improve the probability of their home surviving a fire event.

Three of the four fire departments complete annual S100 and S200 training for all volunteer firefighters and all Officers have Incident Command System (ICS) Level 200. Currently Tla'amin Fire Department is operating with a maximum of two on-call paid staff. Generally, most members have adequate interface training and all the Regional departments have a good relationship with the MFLNRO WMB for interface firefighting support. Halls servicing the Regional District have back-up power systems that are fully functional during a power outage. Response times in the Regional District's core is within 15 minutes however the outer reaches of the Regional District can be up to 45 minutes (*e.g.*, Sarah Point).

Water supply for fire protection throughout the Regional District includes a combination of hydrants, tanks and identified ponds that can be drawn from. Overall water supply has not been identified as a challenge and the departments have established six tanks at five strategic locations throughout the study area. A summary of significant and reliable water supplies for firefighting are listed in Section 3.1.

Emergency Response			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: Improve wildland equipment and enhance fire suppression capabilities across the Regional District.			
18	High	• Support the acquisition of a Regional District shared Sprinkler Trailer resource and provide sprinkler deployment training for all department members. The kit should be able to protect up to 30 interface homes.	$40,000 (one time cost)
19	High	• Support the acquisition of an interface appropriate fire truck for the Northside Fire Department.	$150,000 (one time cost)
20	High	• Maintain current structural and interface training with all Fire Departments and MFLFNRO WMB, and conduct annual reviews to ensure PPE is complete. Interface training should include completion of a mock wildfire scenario in coordination with MFLNRO WMB.	Within current operating costs
21	High	• The Regional District should consider developing an Evacuation Plan in coordination with the RCMP to: map and identify safe zones, marshalling points and aerial evacuation locations; plan traffic control and accident management; identify volunteers that can assist during and/or after evacuation; and create an education/communication strategy to deliver this information to residents. Additionally, the Regional District is encouraged to engage with BC Ferries to explore options and plans to utilize and depend on BC Ferries to assist with community evacuation.	$7,000 + maintenance
22	Moderate	• Support the creation of two career fire fighter positions for the City of Powell River Fire Department toward meeting the four person minimum for a responding company under NFPA 1710.	$150,000 (annually)
23	Moderate	• Support on-call staff recruitment and training for the Tla'amin Fire Department.	Within current operating costs
24	Moderate	• The Regional District should consider supporting options for water access or water storage enhancements for firefighting throughout the Regional District, including increasing the number of hydrants in Malaspina.	Determined based on need
25	Moderate	• Encourage homeowners to post house numbers in a manner that makes them clearly visible to aid emergency response.	Within current operating costs

8.4 VEGETATION MANAGEMENT

Vegetation management (also referred to as fuel management or fuel treatment) is generally considered a key element of the FireSmart approach. Vegetation management is the planned manipulation and/or reduction of living and dead forest fuels for land management objectives (*e.g.*, hazard reduction). Fuel treatments are designed to reduce crown fire through the reduction in surface fuels, ladder fuels and crown fuels. This threshold of reduction varies by ecosystem type, present fuel type, fire weather, slope, and other variables.

Vegetation management can be an effective method of reducing fire behaviour; however it is important to note that it does not stop wildfire. The purpose of altering vegetation for fire protection must be evaluated against the other key CWPP elements (outlined above) to determine its necessity.

Vegetation management can be undertaken with minimal negative or even positive impact on the aesthetic or ecological quality of the surrounding forest and does not mean removing most of the trees. The focus for vegetation management in the interface Is not necessarily to stop fire, but to ensure that fire severity is low enough that fire damage is limited. For example, treating around a home may prevent structure ignition due to direct flame contact and then the ability of the home to survive the fire would come down to whether construction materials can survive ember attack. The intent of vegetation management is not to stop the fire but to reduce fire severity.

The vegetation management objectives for the Regional District are:

- To protect homes and critical infrastructure by proactively reducing potential fire behaviour.
- To encourage BC Hydro to maintain fuels (including broom) beneath power lines in a low hazard state.

In the Regional District, vegetation management work has only been completed on Savary Island and no vegetation management work has been completed throughout the study area. One significant constraint with vegetation management is private land and Tla'amin Reserve land with hazardous fuels. Funds from public sources such as the UBCM are strictly for Crown lands and cannot be used to treat private and Reserve lands; however fuels on these lands pose one of the greatest risks to the community. The best approach to mitigate fuels on private lands is to promote FireSmart (as described above). A FireSmart approach to vegetation management within 100 m of structures is considered beneficial in order to improve defensible space around structures, and to reduce the likelihood that a house fire could spread to adjacent forests. In general, when considering vegetation management to reduce fire risk, the following steps should be followed:

- A qualified professional forester should develop the prescription(s);
- Public consultation should be conducted during the process to ensure community support;
- Treatment implementation must weigh the most financially and ecologically beneficial methods of fulfilling the prescription goals;
- An environmental monitor should be involved in ensuring that the treatments are correctly implemented;
- Pre- and post-treatment plots should be established to monitor treatment effectiveness; and

- A long-term maintenance program should be in place to ensure that the fuel treatment is maintained in a functional state.

Securing funds to subsidize a vegetation management program for the Regional District would require partnerships/support from potential stakeholders, including timber operators and BC Hydro. Formerly the UBCM provided funding for communities with a CWPP however this funding is currently not available. It is recommended that the Regional District develop a fund to independently support the development and implementation of vegetation management.

To assess risk, the Provincial *WUI Wildfire Threat Rating Worksheets* were used, as required by UBCM[11]. This worksheet provides point ratings for four components that contribute to wildfire risk. These components include fuels, weather, topography and structural values at risk. The most predominant hazardous fuel types identified throughout the study area include C2 and C4 (Priority 1 fuel type) followed by C3 (Priority 2 fuel type) (Map 8). Interface areas such as the area surrounding Covey Street and Theodosia Ave were identified during field assessments as areas with a high *Wildfire Behaviour Threat Class* and an extreme *WUI Threat Class* (based on the *Wildfire Threat Rating Worksheet*) and it is recommended that these areas be prioritized for future fuel treatments. In summary, Areas that were identified with high *Wildfire Behaviour Threat R*atings and extreme *WUI Threat Ratings Assessments* and additional areas of interest, based strictly on proximity to hazardous fuel types (spatial review), that should be reviewed for fuel treatments are summarized in Table 4.

Table 4. Potential treatment areas and recommended treatment type.

Plot	Priority (1 and 2)	Fuel Type	Recommended Treatment Type	Comments
268	1	C3	Thin from below, prune and surface fuel removal	Located northeast of the City center, above Theodosia Avenue and east of Yew Kwum Place. Access is good.
65	1	C3	Thin from below, prune and surface fuel removal	Located east of Tanner Avenue. Access is good.
100 / 109	1	C3	Thin from below, prune and surface fuel removal	Surrounding Lamb Street and Roberts Road. Access is good.
300	1	C3	Thin from below, prune and surface fuel removal	Located north of Masters Road/north of the Sunshine Coast Highway. Access is good.
277	1	C3	Thin from below, prune and surface fuel removal	Located north of the Sunshine Coast Highway between Southill Road and Rifle Range Road.
63	2	C3	Thin from below, prune and surface fuel removal	Located north of the City center, south of Covey Street. Access is good.

Further information regarding the WUI assessments is outlined above in Section 6.2.

There is an increase in ignition potential associated with tree contact with wires along BC Hydro ROWs and through the build-up of fuels. Right-of-way management is important in keeping the wildfire hazard risk low. Where feasible and when managed in a low hazard condition ROWs could be established fuel breaks around the communities. Additionally, vegetation management programs could be planned to enhance naturally occurring fuel breaks (*e.g.,* around ROWs, lakes, non-fuel areas, etc.).

Vegetation Management			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: Reduce wildfire threat on private and public lands through vegetation management.			
26	High	• The Regional District should work with/encourage BC Hydro to reduce fire risk along Hydro right-of-ways. BC Hydro should ensure that transmission infrastructure can be maintained and managed during a wildfire event.	See recommendation #1
27	High	• The Regional District should encourage BC Hydro to ensure that the ROW vegetation management strategy considers managing Scotch broom beneath transmission lines that contribute to unacceptable fuel loading and diminished the ability of the ROW to act as a fuel break.	Within current operating costs
28	High	• The Regional District should identify potential partnerships to fund a vegetation management program and encourage UBCM to re-instate funding for vegetation management.	Within current operating costs
29	High	• The Regional District should consider establishing a fund to develop and implement a vegetation management program and for future maintenance.	$25,000 annually
30	High	• Based on funding availability, the Regional District should prioritize vegetation management prescription development in the identified high hazard areas (Priority 1 and Priority 2) with the support of a qualified professional forester.	Determined based on need and funding
31	High	• Use a combination of bylaws/development permit areas and public education to encourage private land owners to reduce the fire hazard on their properties.	See recommendation #1
32	Moderate	• The Regional District should work forest operators (*e.g.*, licensees, woodlot operators, private land owners, *etc*.) to reduce fire risk in their operating areas and work with the MFLNRO WMB to enforce hazard abatement as outlined in the Wildfire Act and Regulation, specifically within 2 km of the interface zone.	See recommendation #1

9.0 REFERENCES

Alenxander, M.E. 2003. Understanding Fire Behavior – The key to effective fuels management. Fuel management workshop. Hinton, BC.

Ministry of Forests, Lands and Resource Operations. 2014. Wildfire Management Branch – Fire Behaviour. Weblink: http://bcwildfire.ca/FightingWildfire/behaviour.htm; Accessed: January 2015.

Pike, R.G., M.C. Feller, J.D. Stednick, K.J. Rieberger, M. Carver. 2009. Chapter 12- Water Quality and Forest Management [Draft]. *In* Compendium of Forest Hydrology and Geomorphology in British Columbia [In Prep.]R.G. Pike *et al.* (editors). B.C. Ministry of Forests, Mines and Lands Research Branch, Victoria B.C. and FORREX Forest Research Extension Partnership, Kamloops, B.C. Land Management Handbook (TDB). URL: http://www.forrex.org/program/water/PDFs/Compendium/Compendium_Chapter12.pdf (accessed May 2014)

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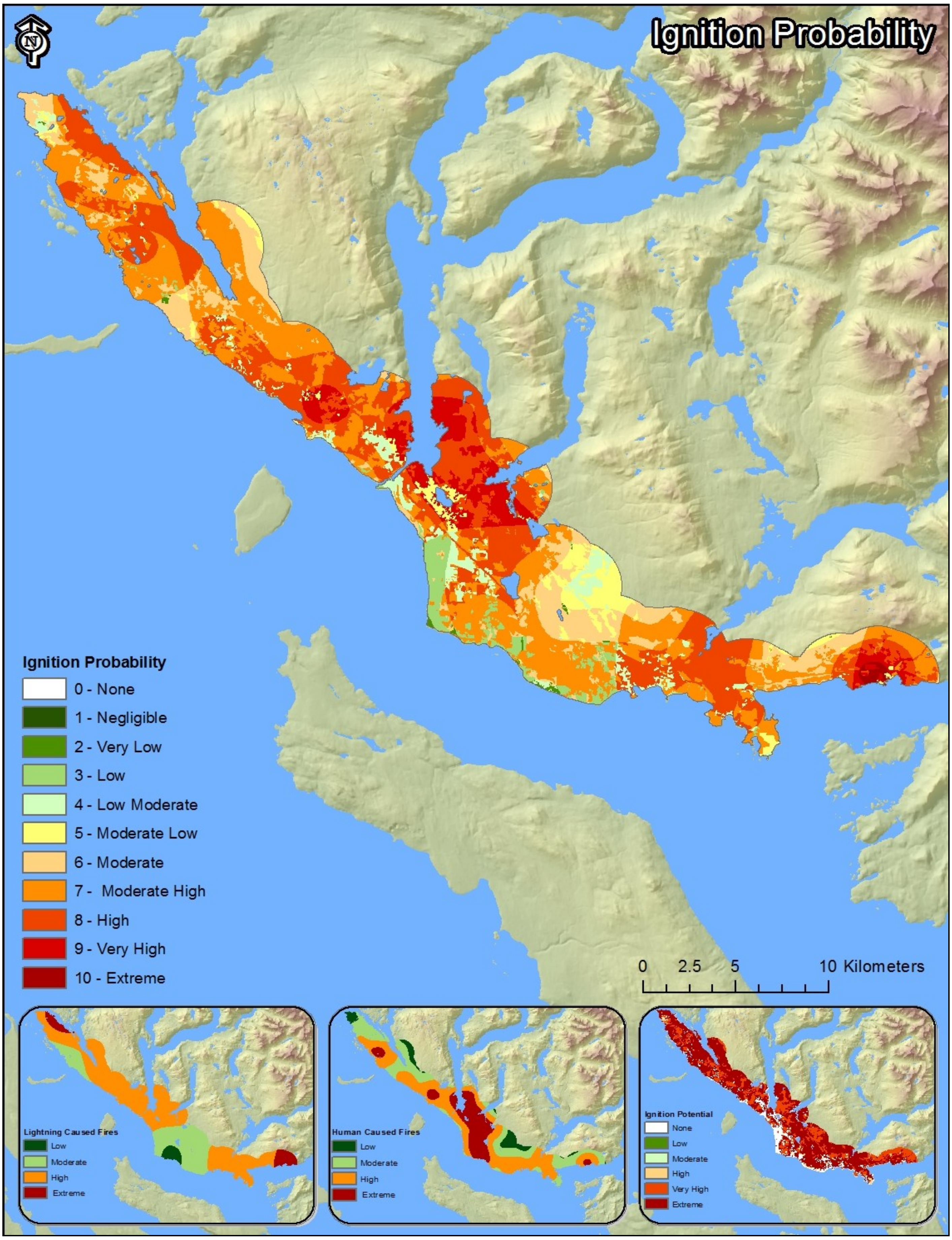
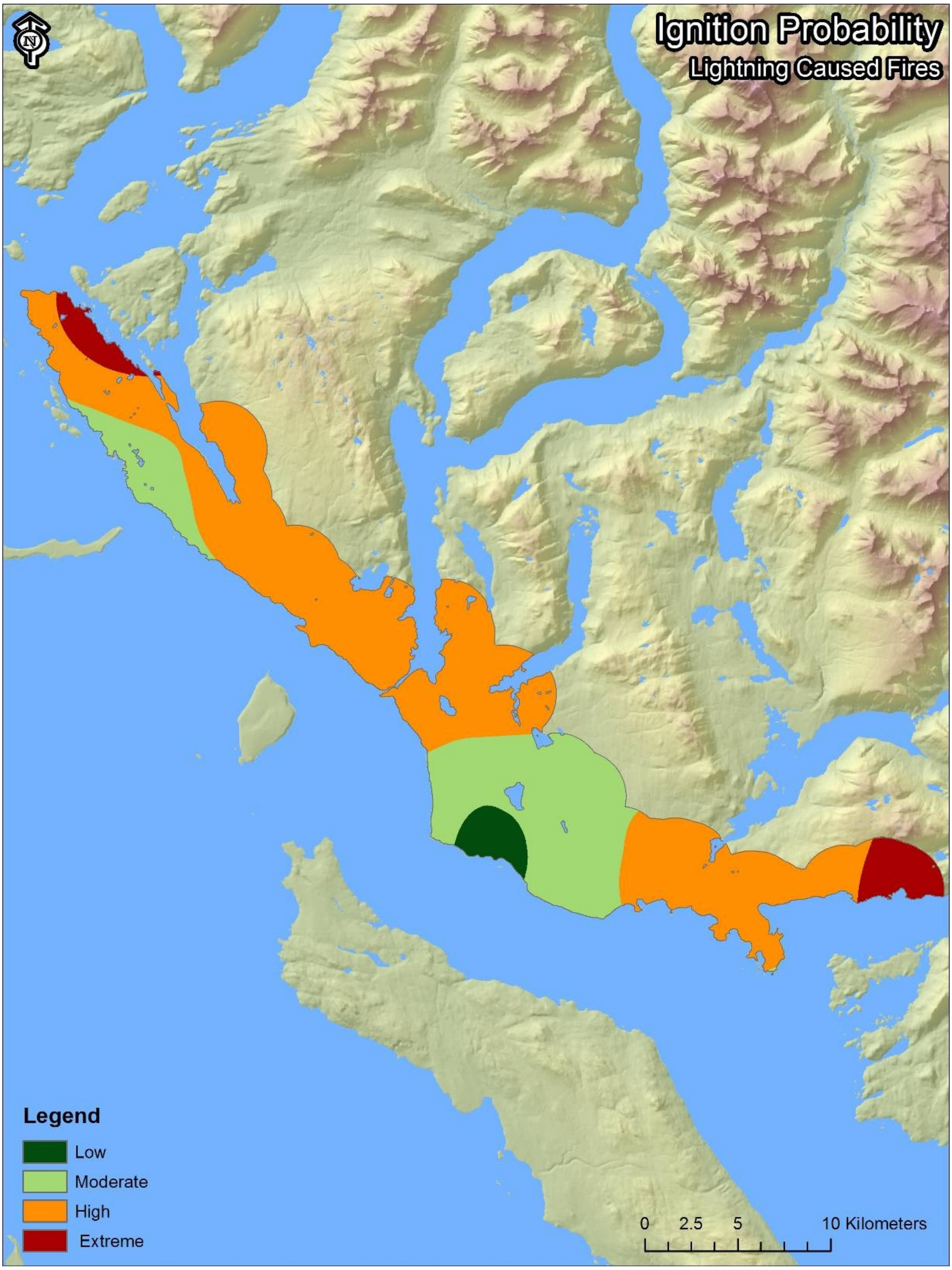
APPENDIX A: WRMS MAPS

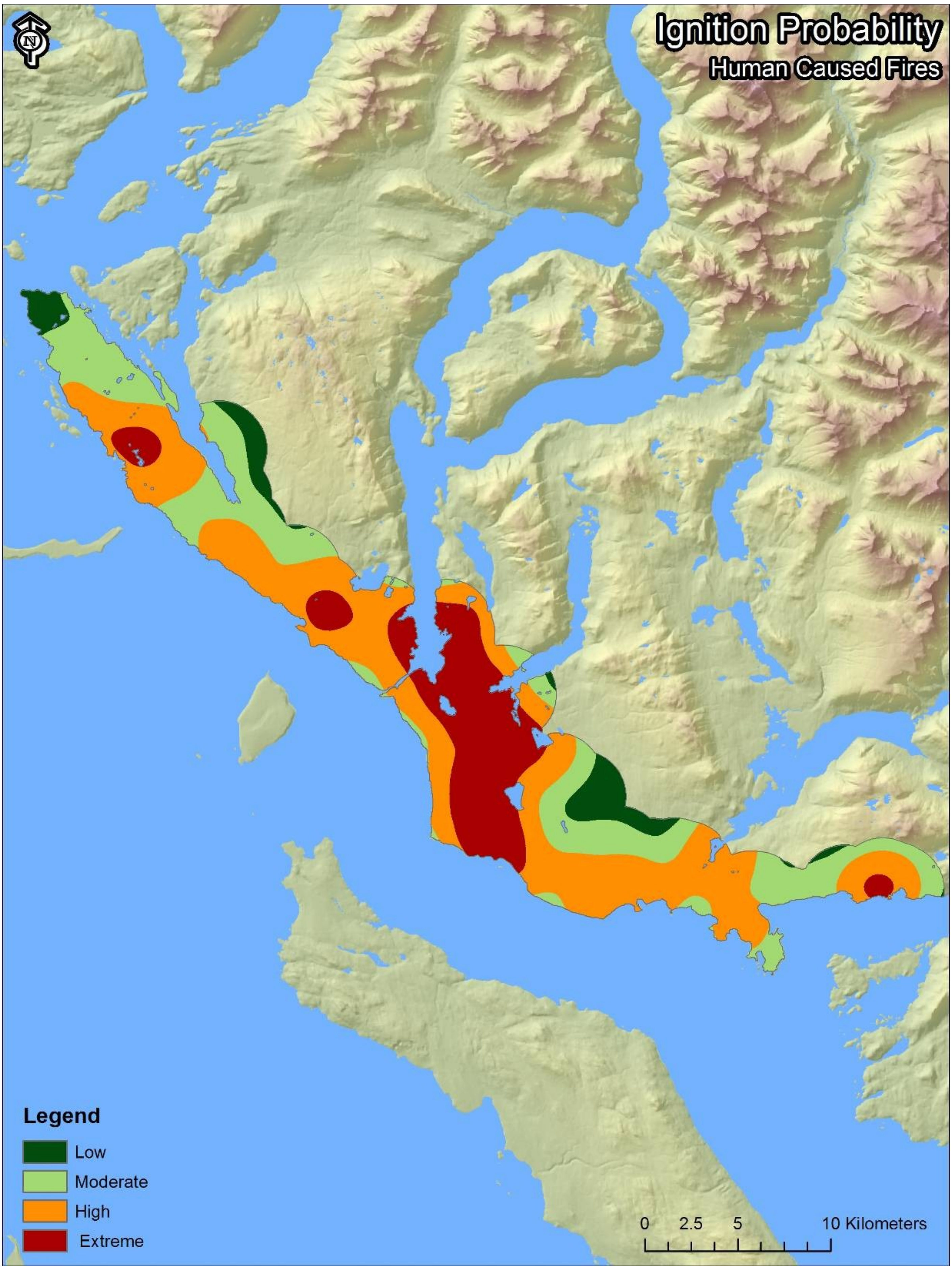
PROBABILITY: PROBABILITY OF IGNITION



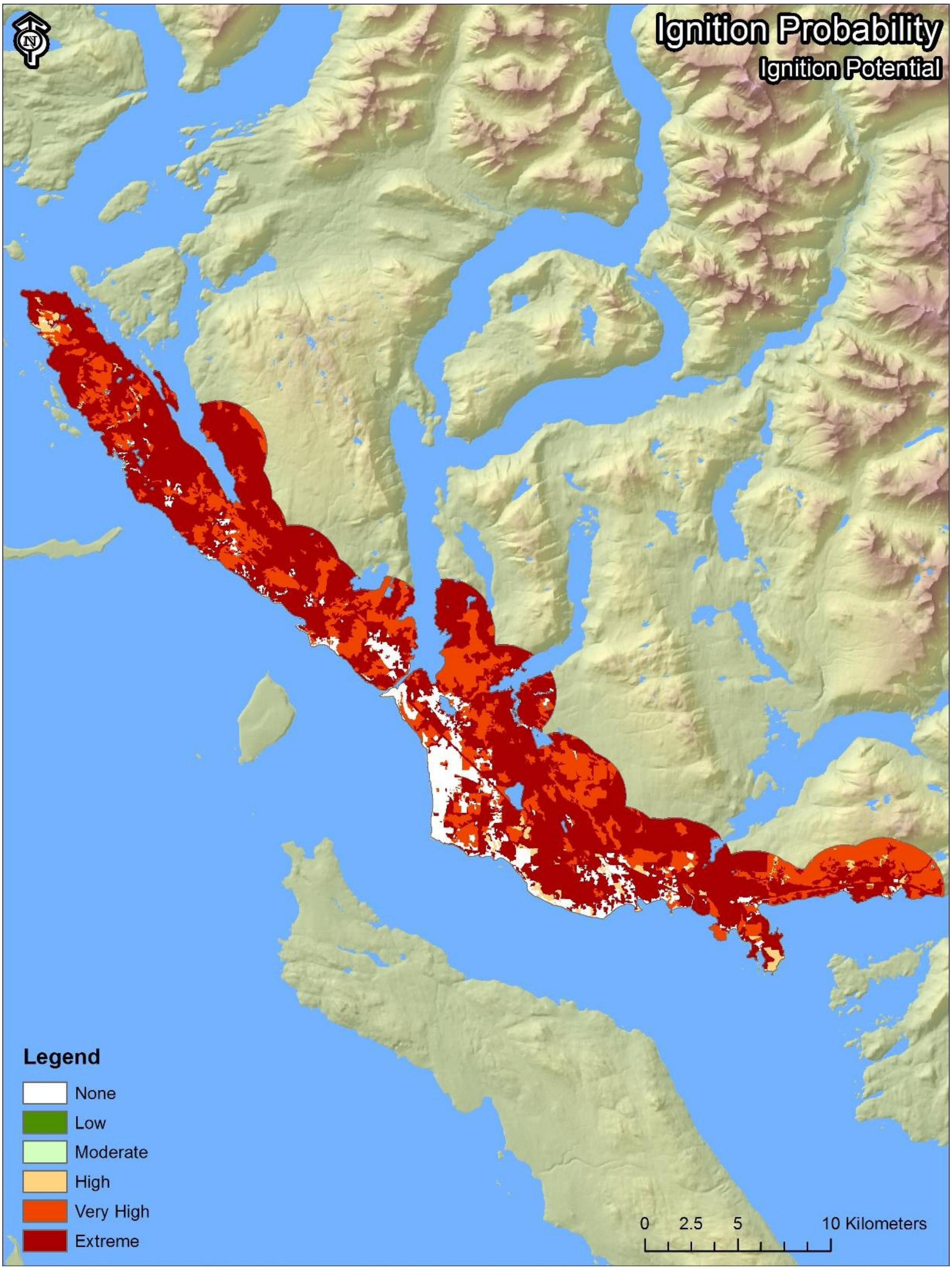
PROBABILITY OF IGNITION: LIGHTNING CAUSED FIRES



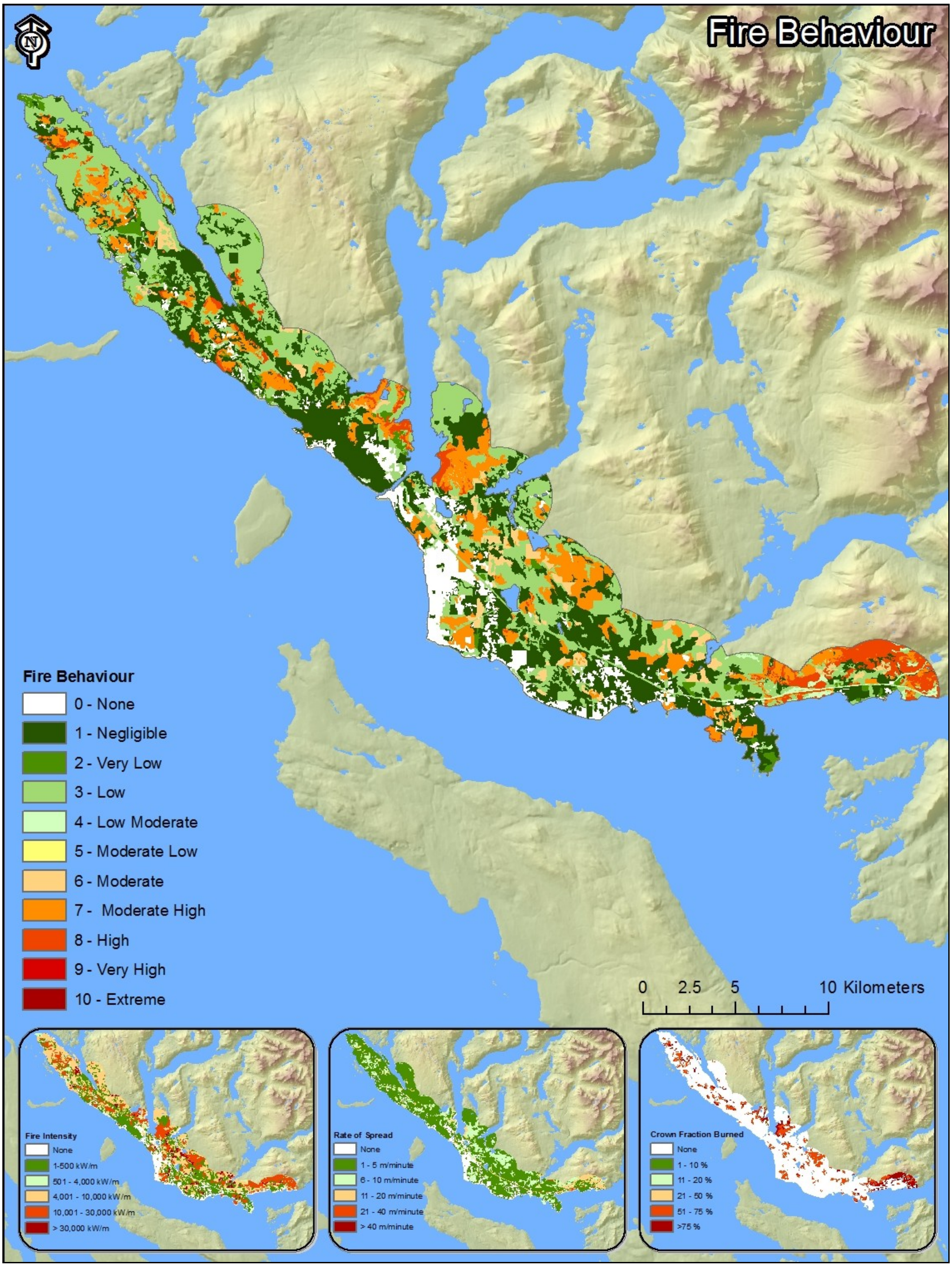
PROBABILITY OF IGNITION: HUMAN CAUSED FIRES



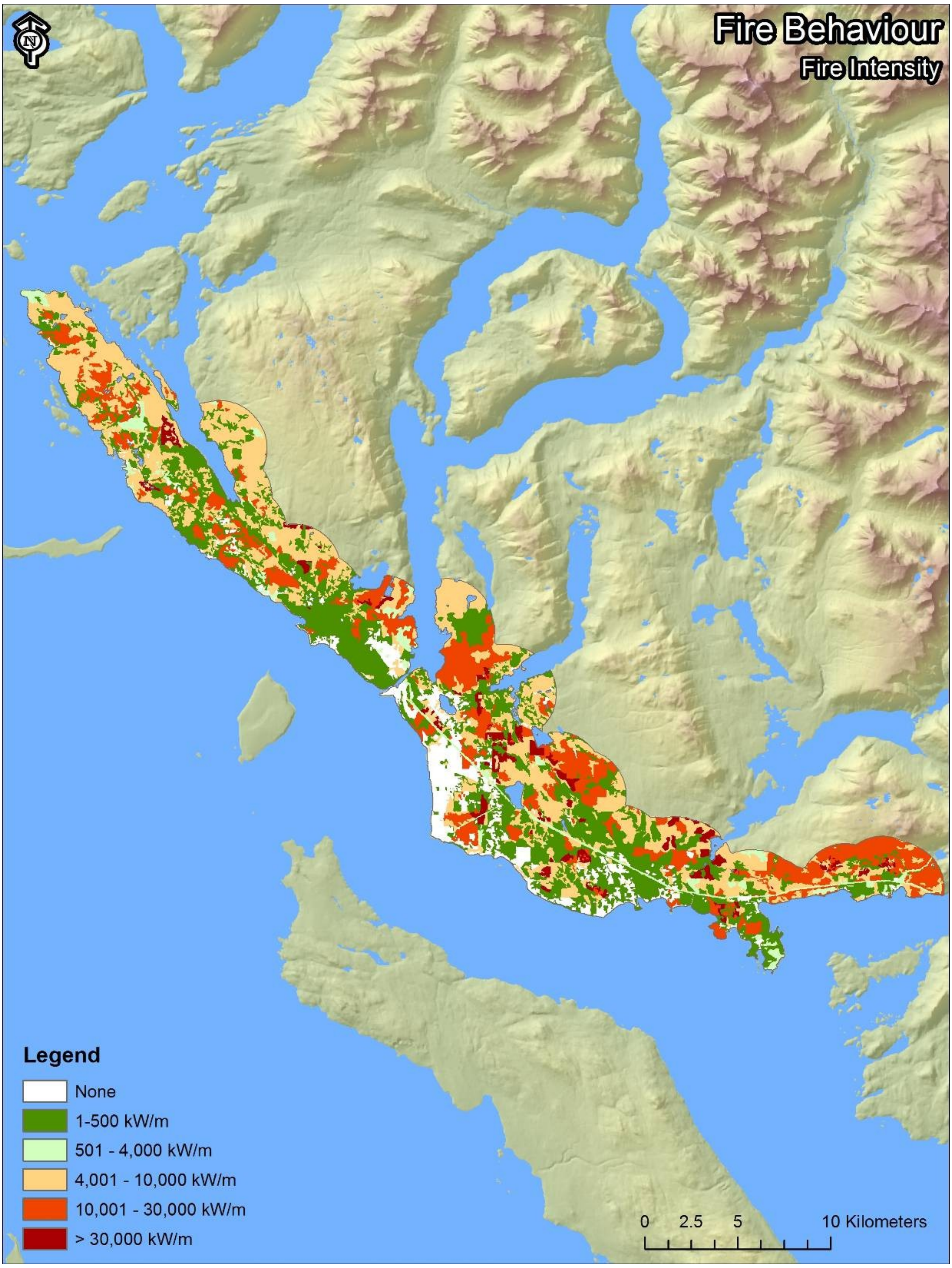
PROBABILITY OF IGNITION: IGNTION POTENTIAL



PROBABILITY: POTENTIAL FIRE BEHAVIOUR

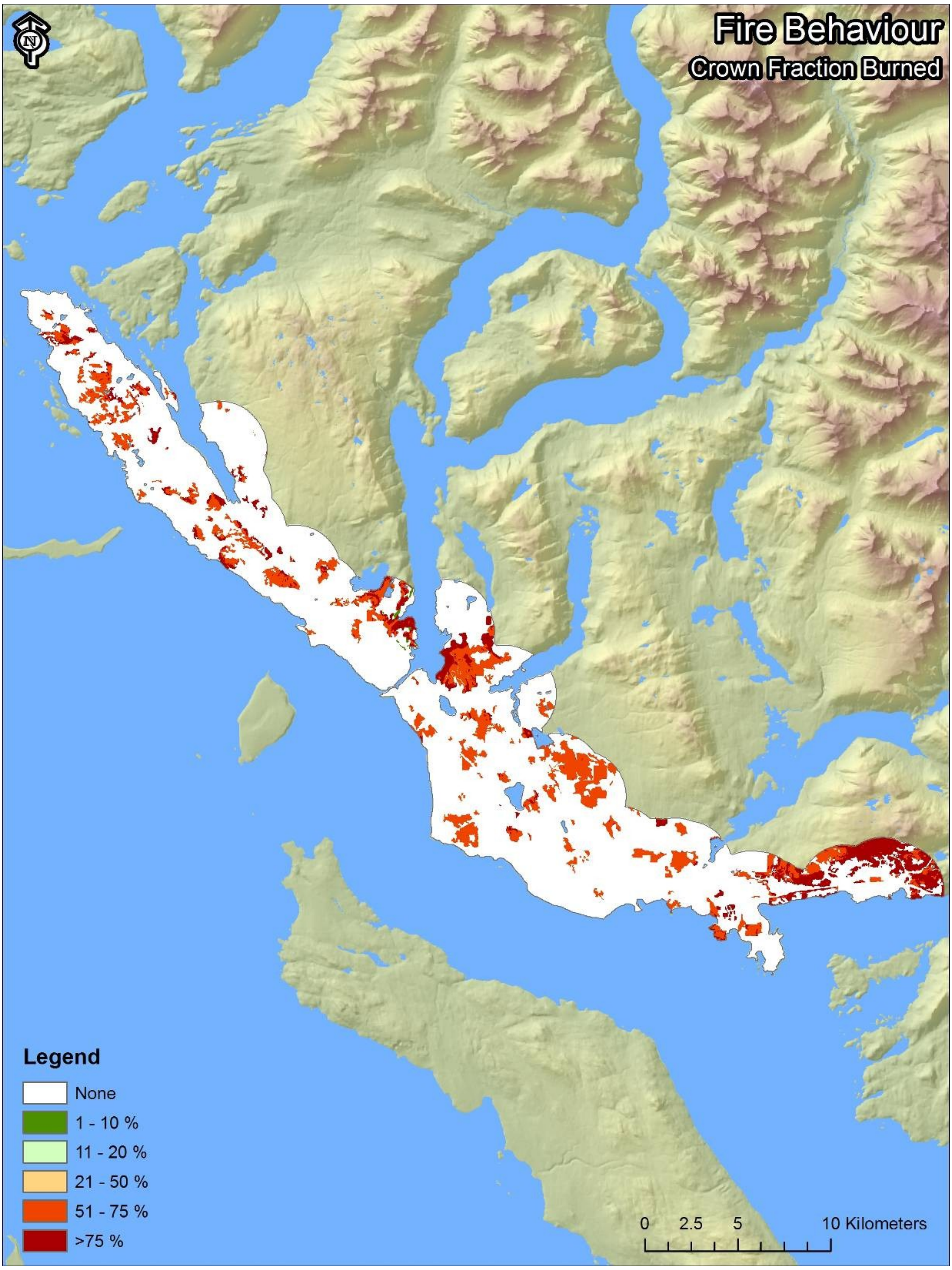


POTENTIAL FIRE BEHAVIOUR: FIRE INTENSITY

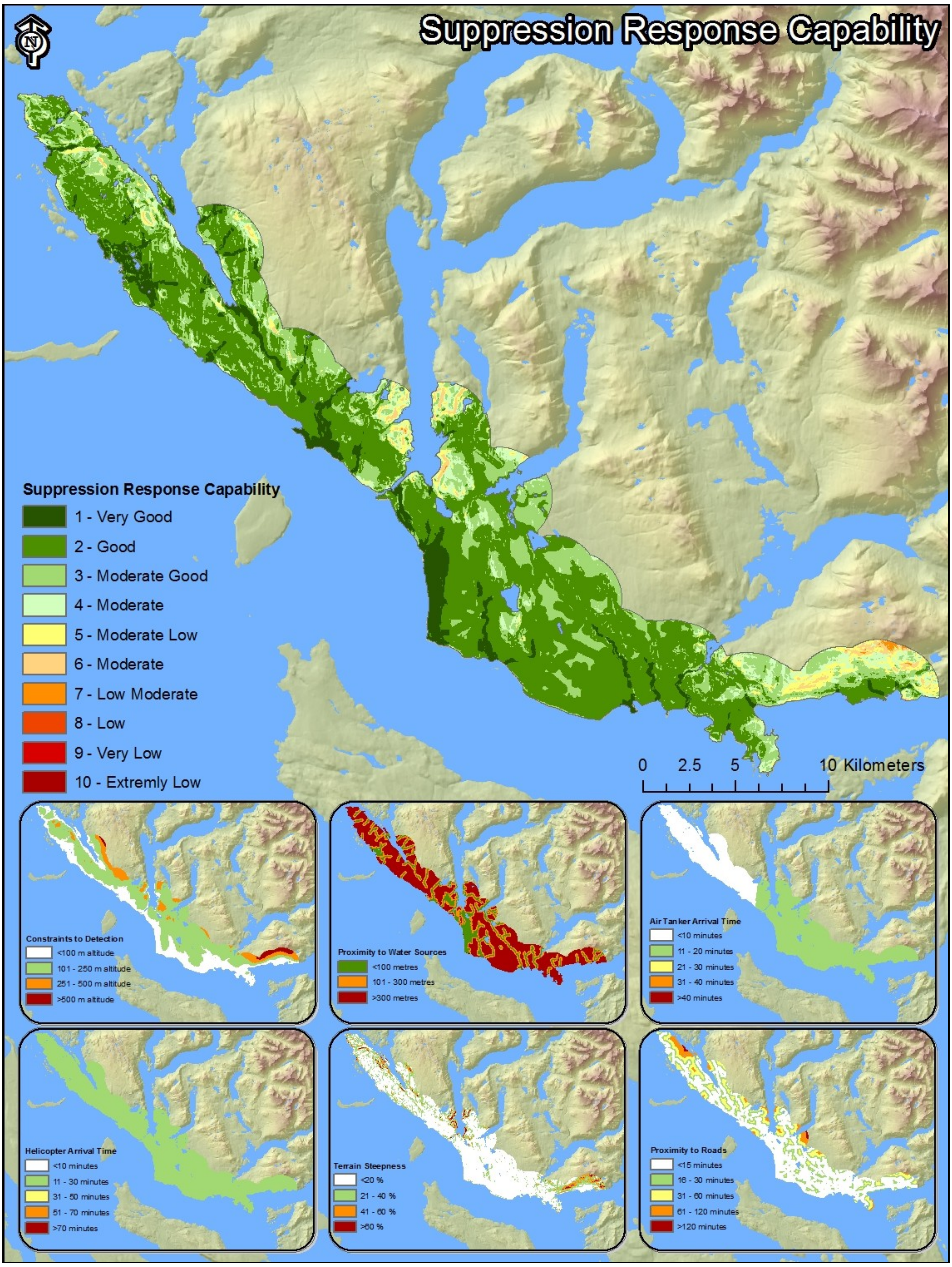


POTENTIAL FIRE BEHAVIOUR: RATE OF SPREAD

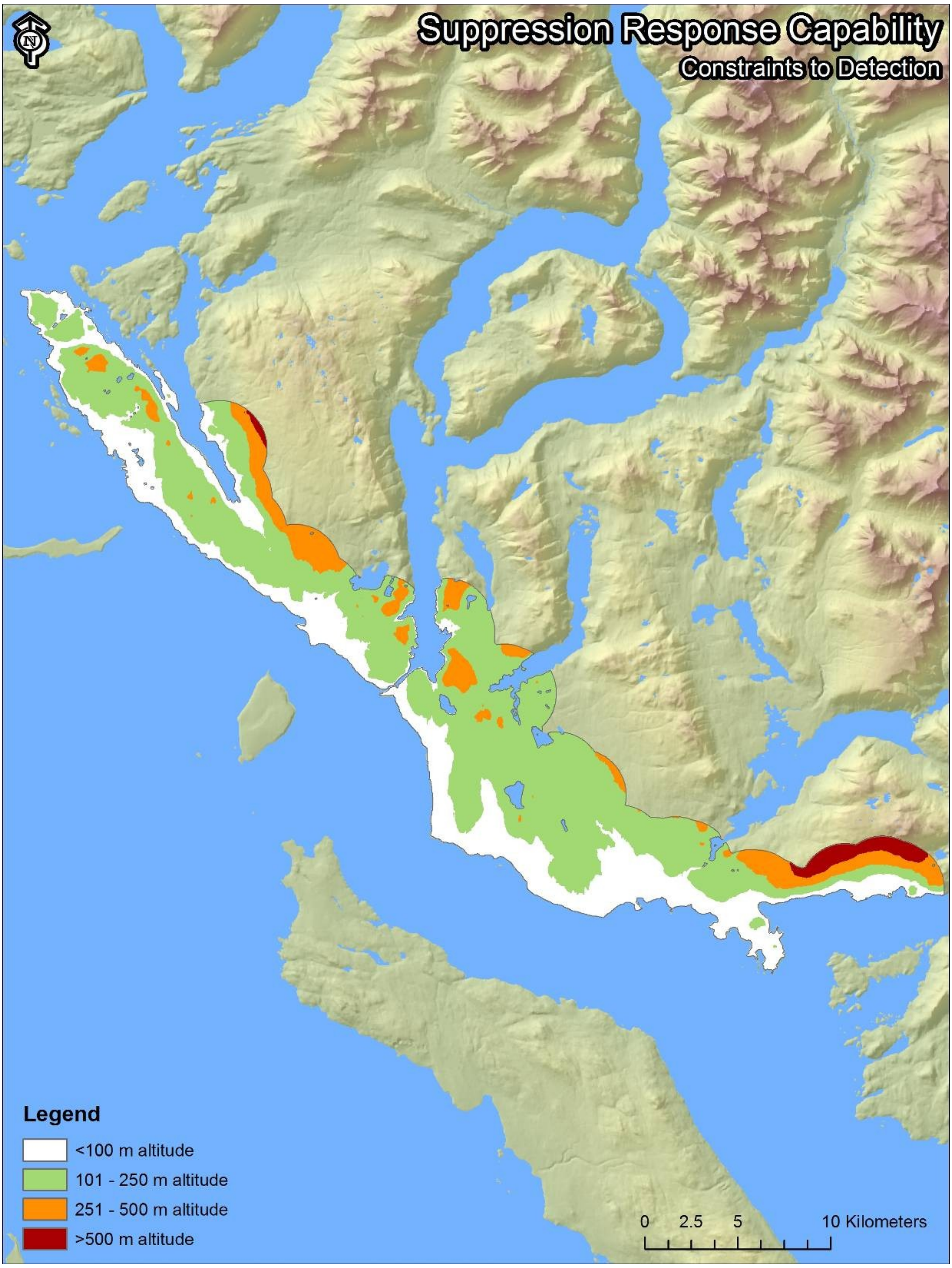
POTENTIAL FIRE BEHAVIOUR: CROWN FRACTION BURNED



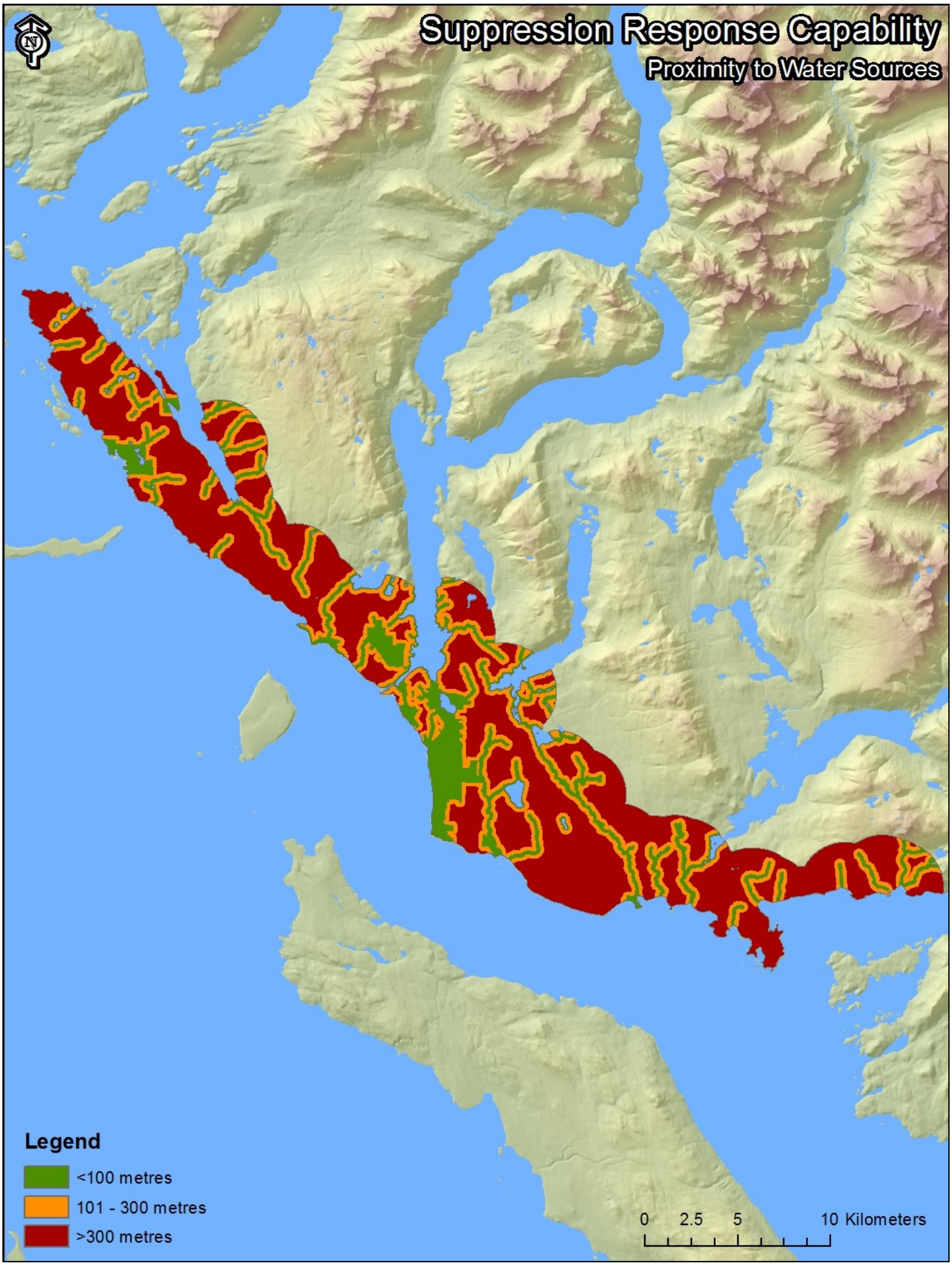
PROBABILITY: SUPPRESSION RESPONSE CAPABILITY



SUPPRESSION RESPONSE CAPABILITY: CONSTRAINTS TO DETECTION

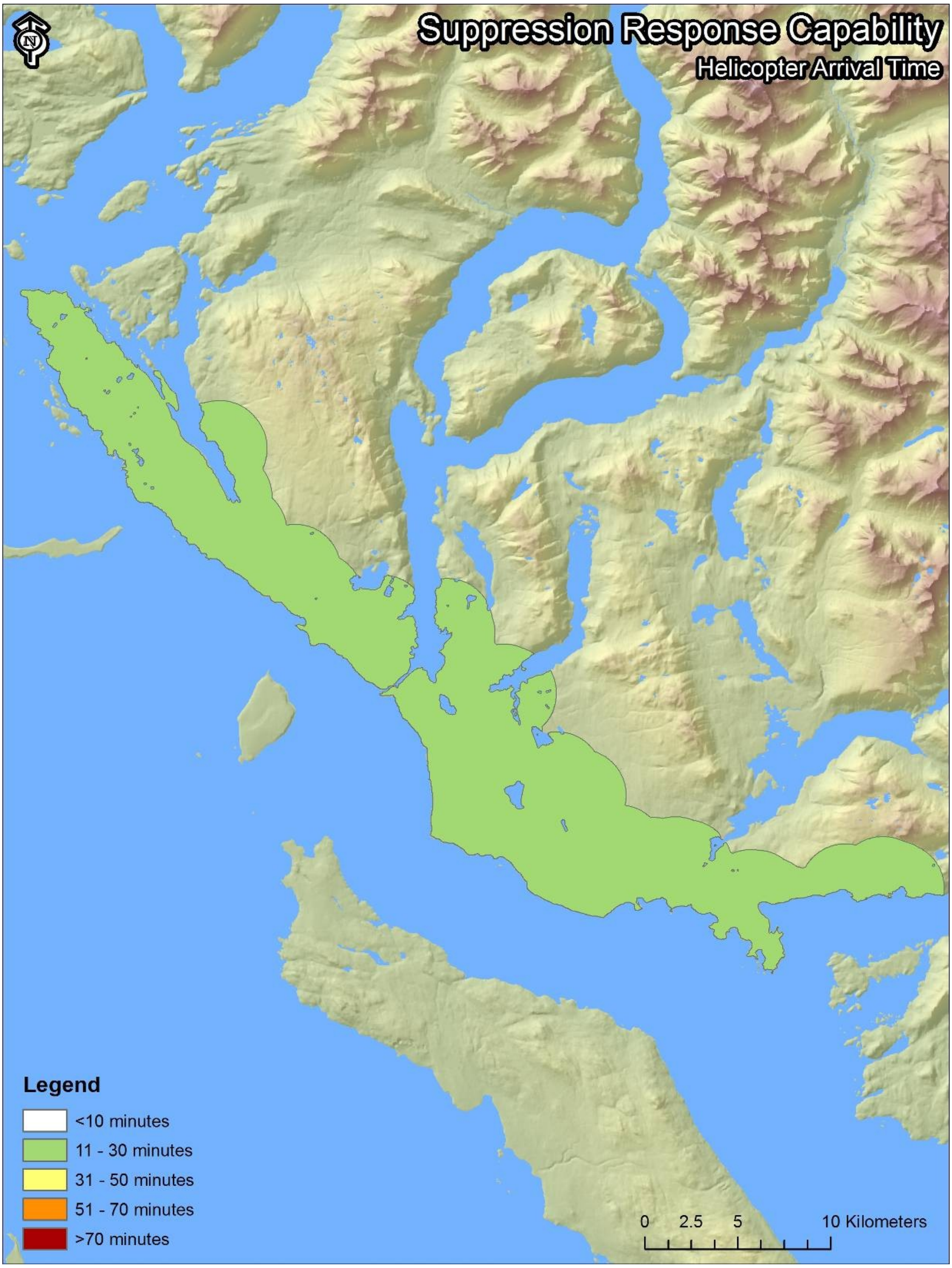


SUPPRESSION RESPONSE CAPABILITY: PROXIMITY TO WATER SOURCES

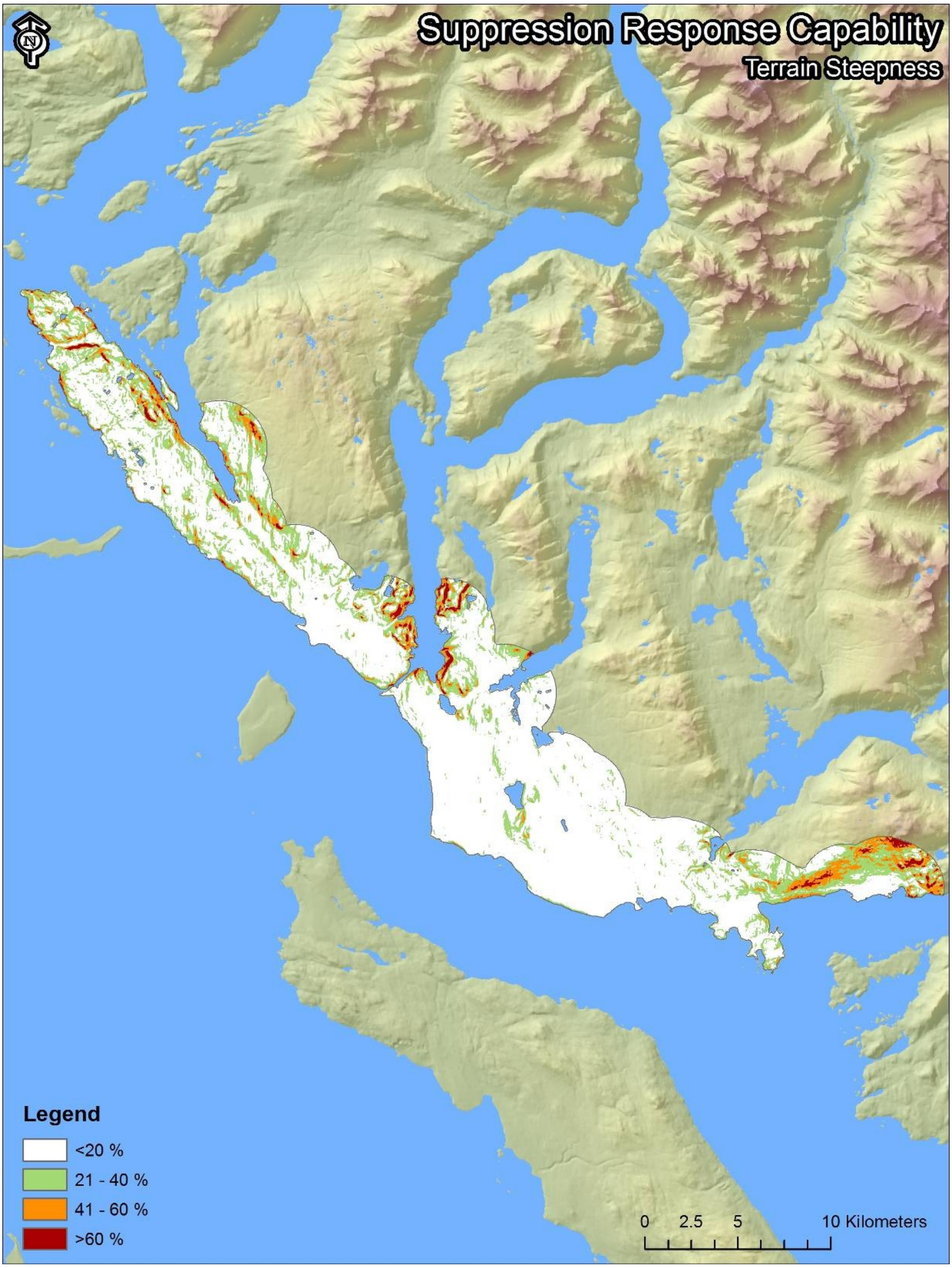


SUPPRESSION RESPONSE CAPABILITY: AIR TANKER ARRIVAL TIME

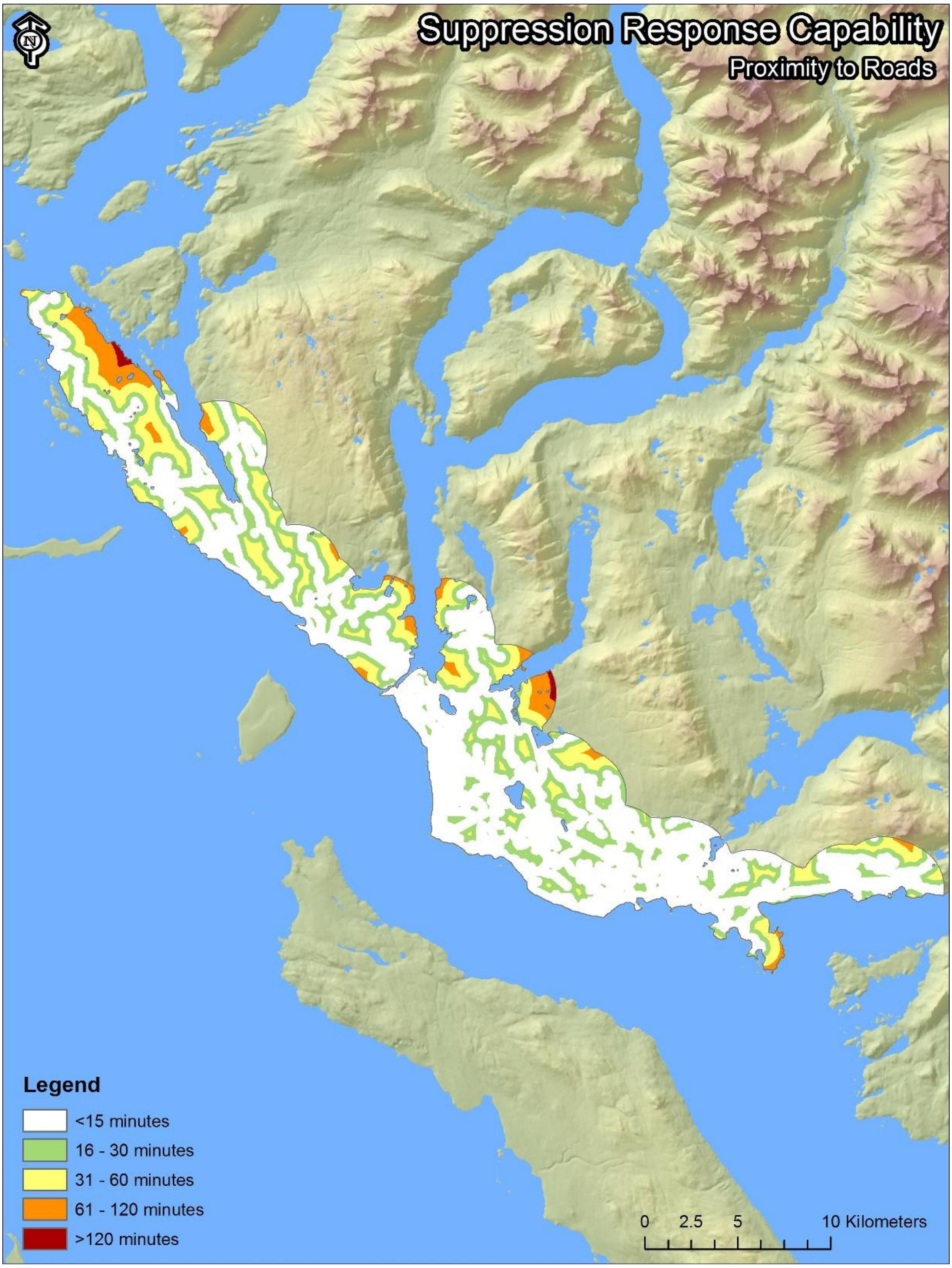
SUPPRESSION RESPONSE CAPABILITY: HELICOPTER ARRIVAL TIME



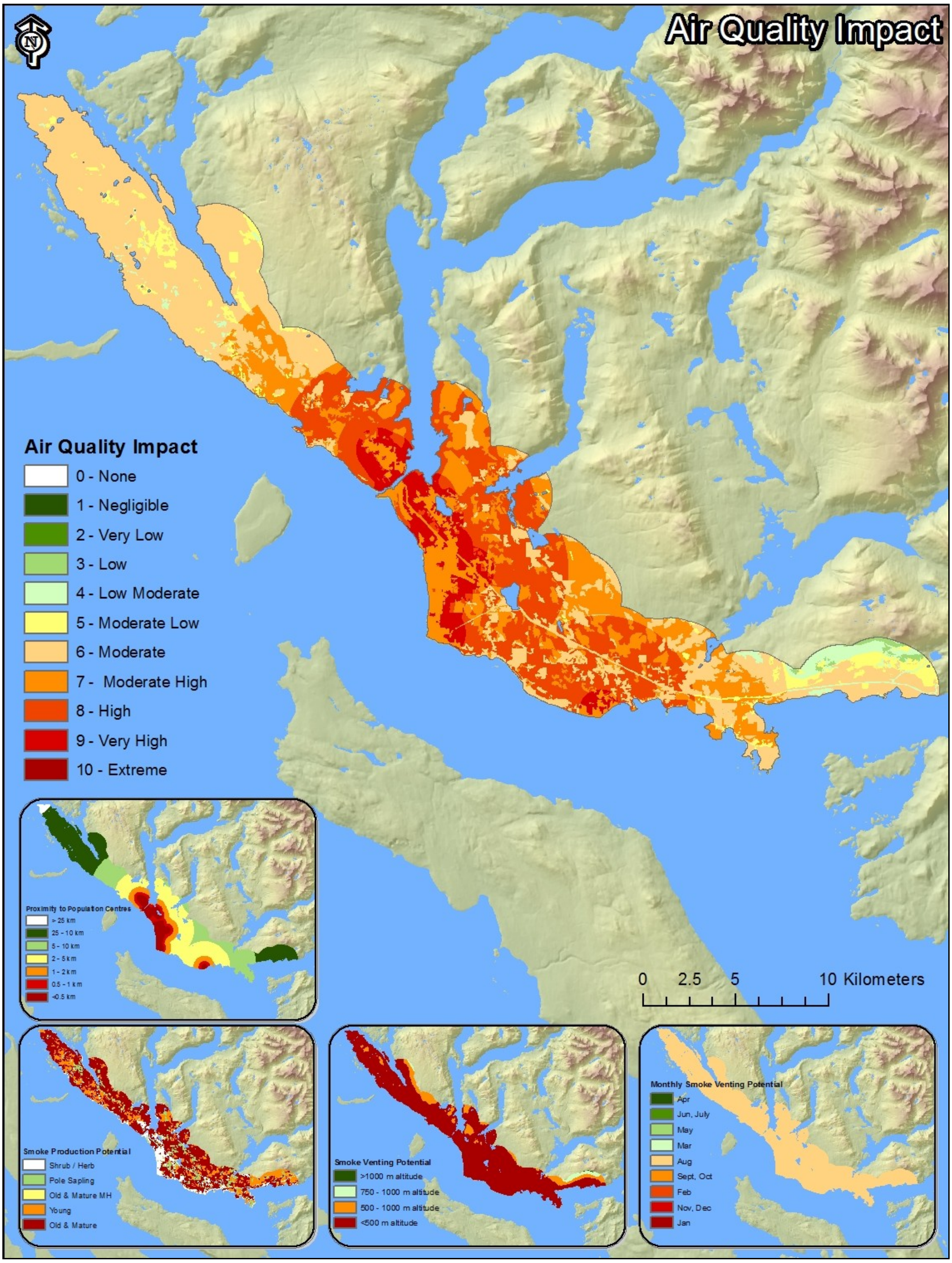
SUPPRESSION RESPONSE CAPABILITY: TERRAIN STEEPNESS



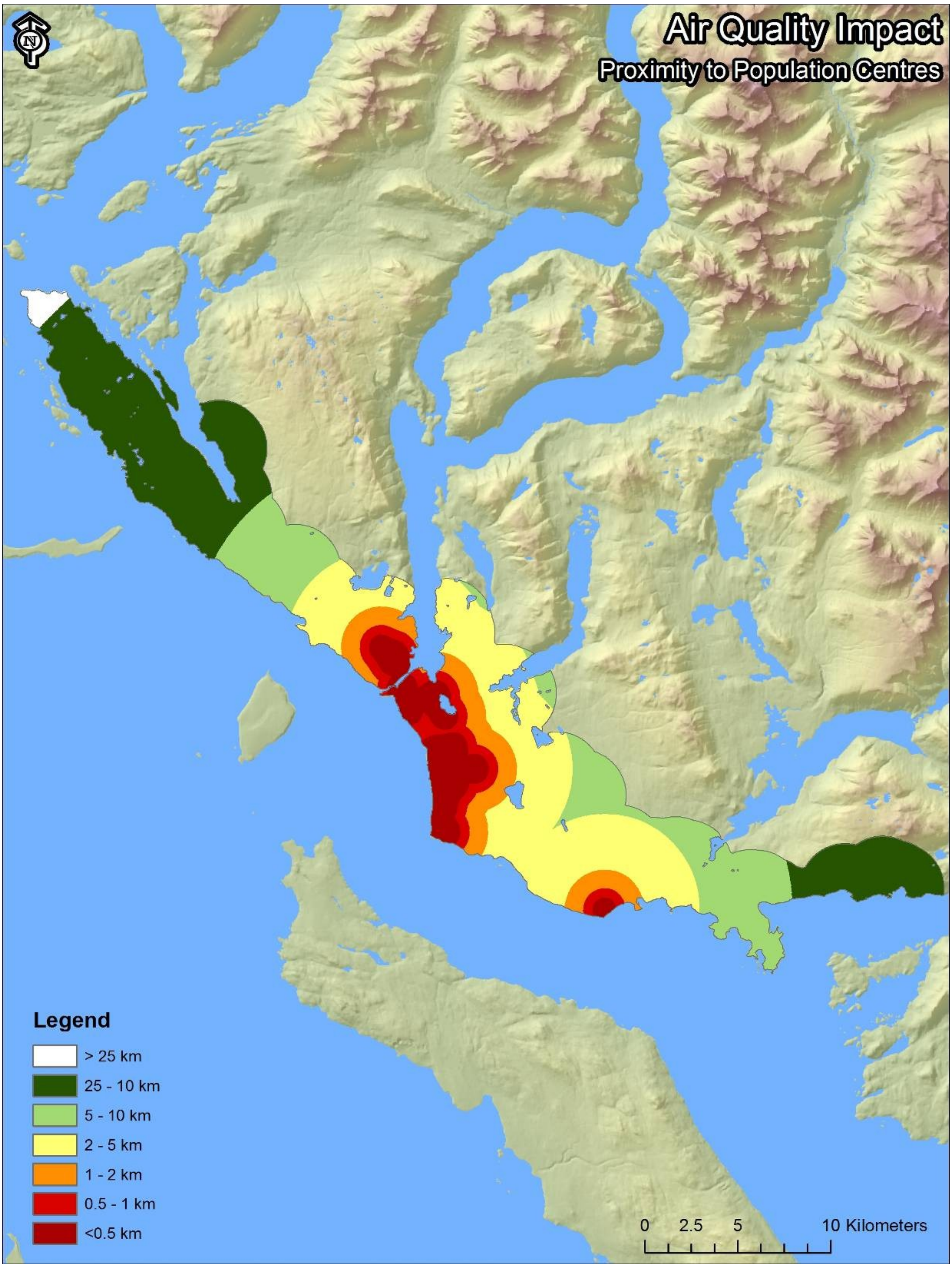
SUPPRESSION RESPONSE CAPABILITY: PROXIMITY TO ROADS



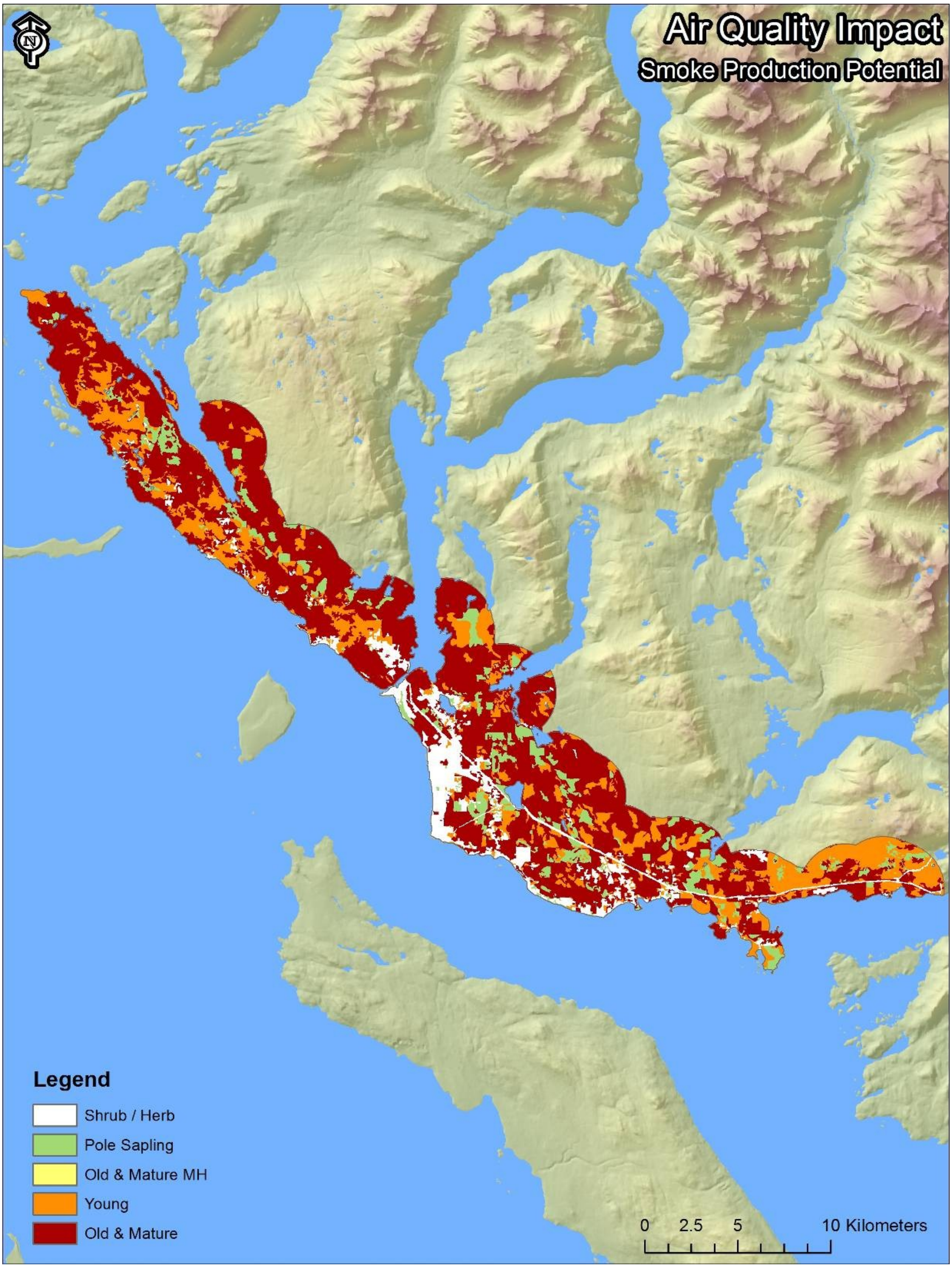
CONSEQUENCE: AIR QUALITY



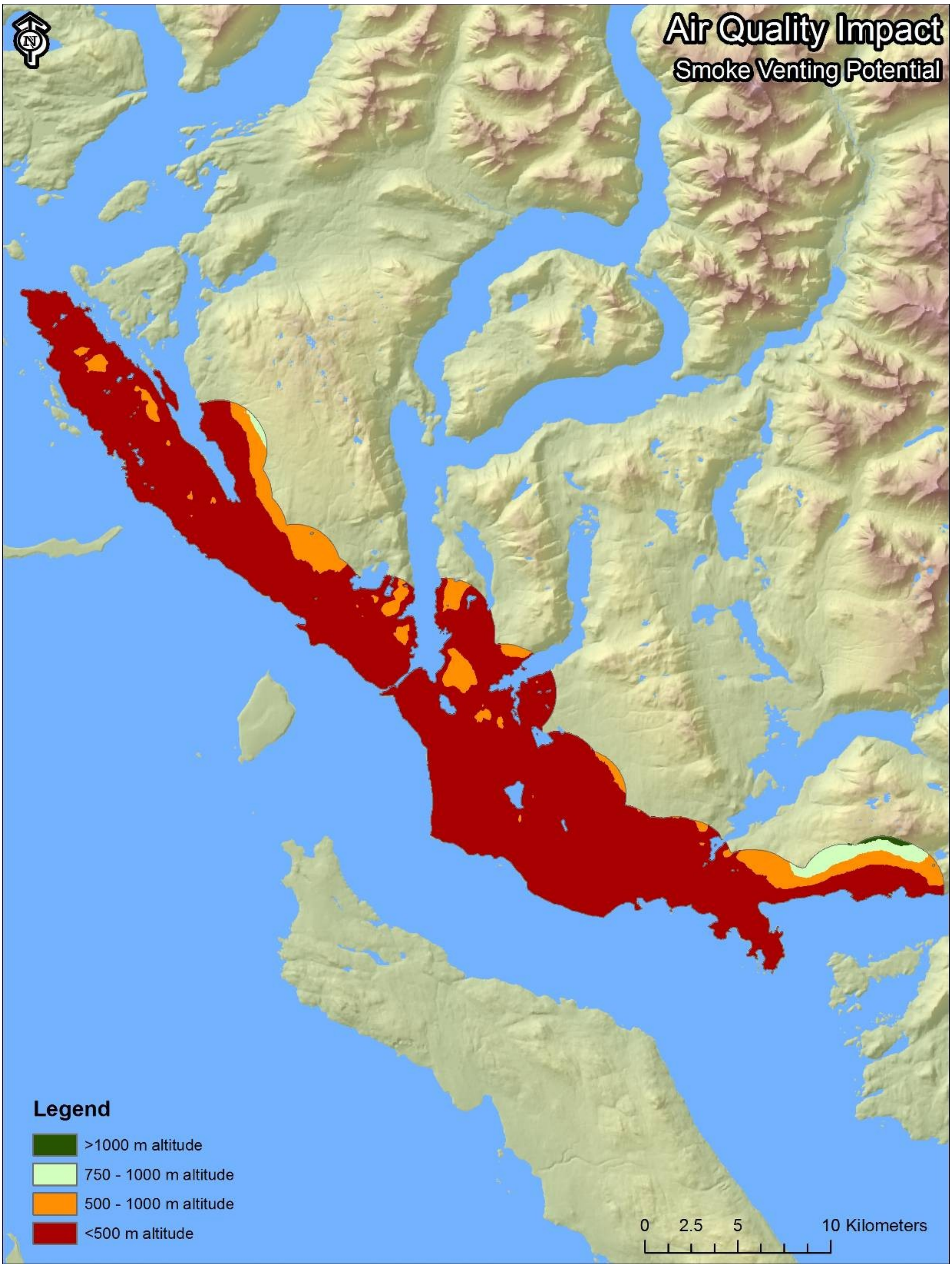
AIR QUALITY: PROXIMITY TO POPULATION CENTERS



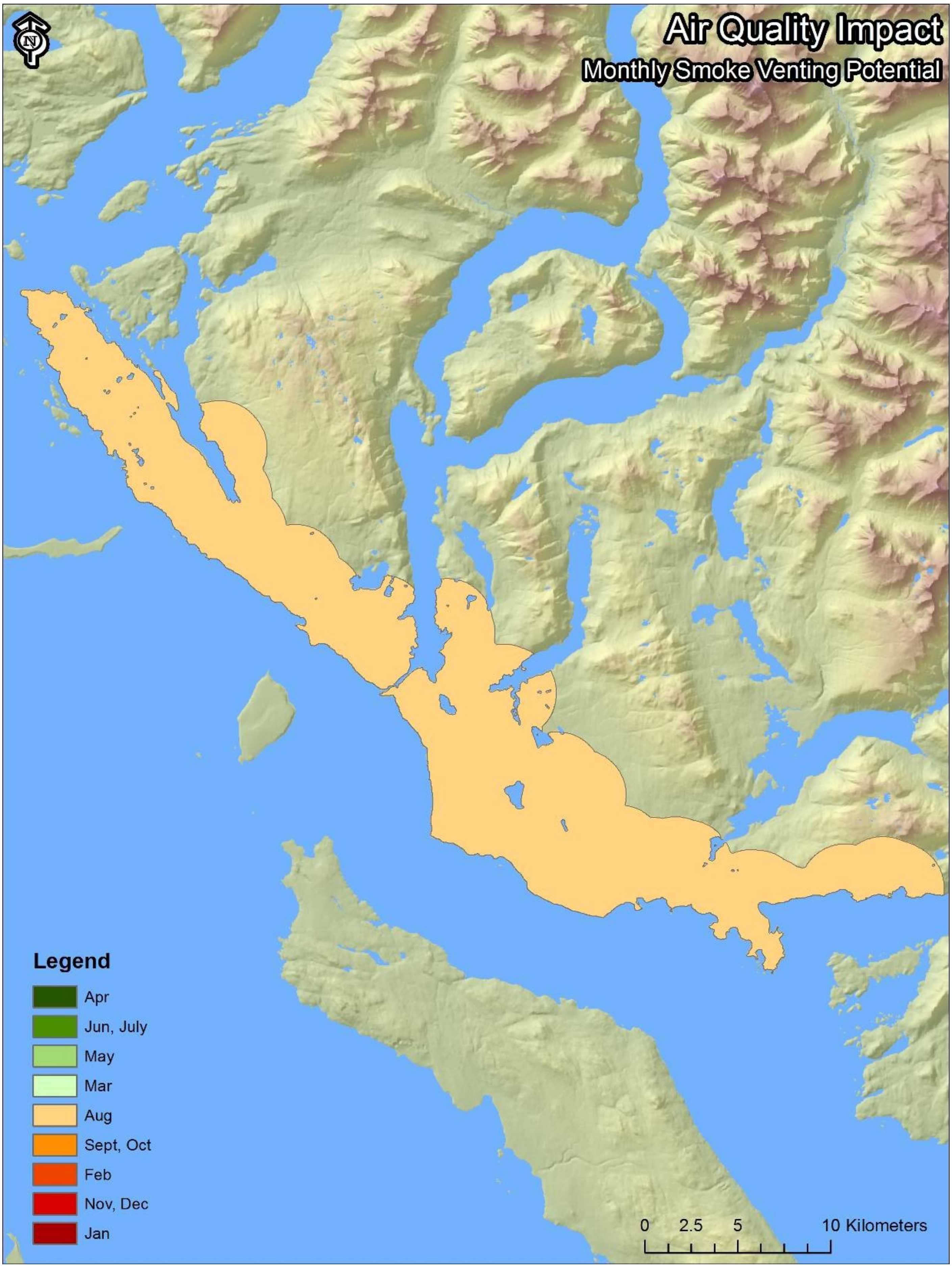
AIR QUALITY: SMOKE PRODUCTION POTENTIAL



AIR QUALITY: SMOKE VENTING POTENTIAL

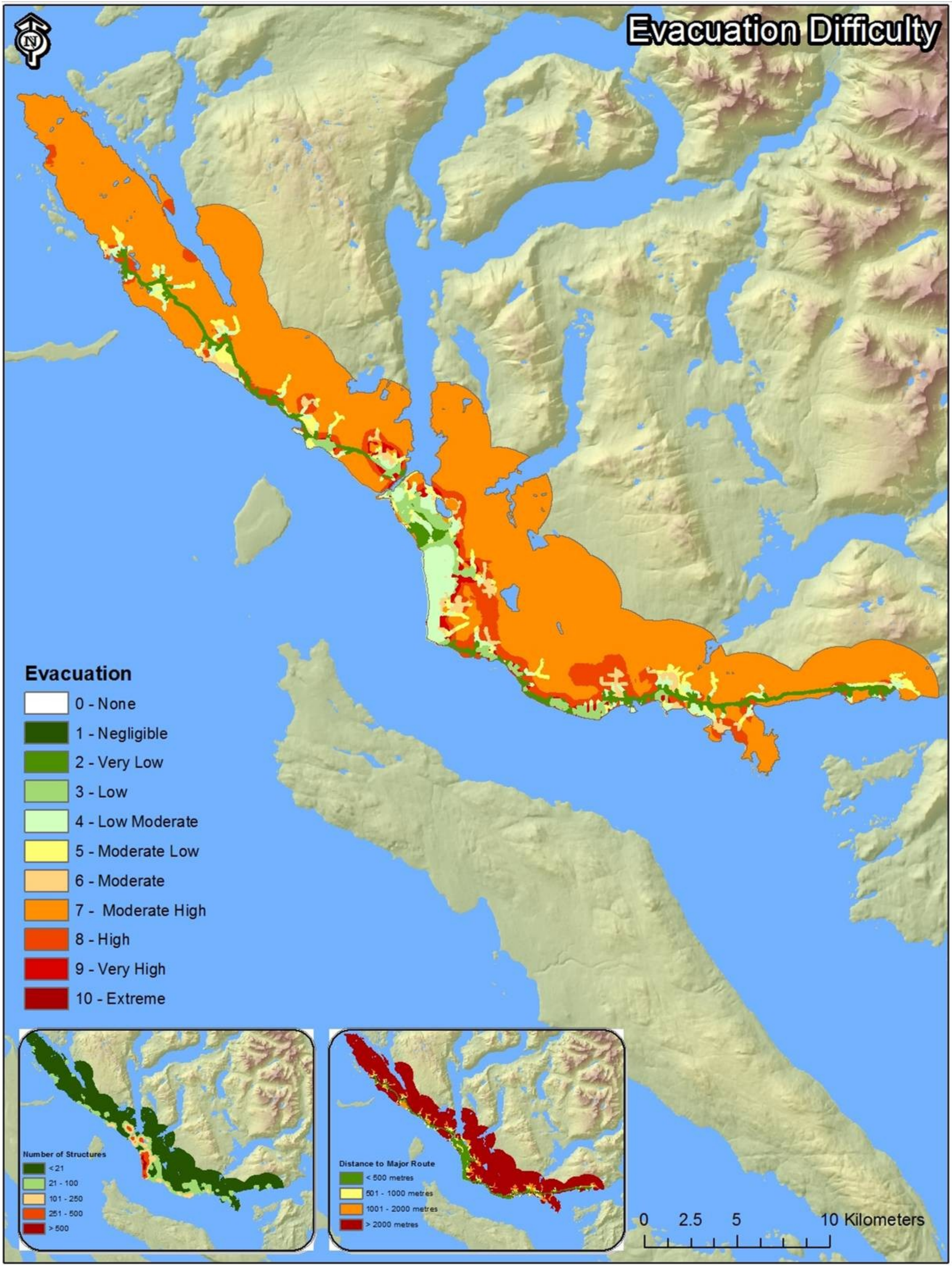


AIR QUALITY: MONTHLY SMOKE VENTING POTENTIAL*

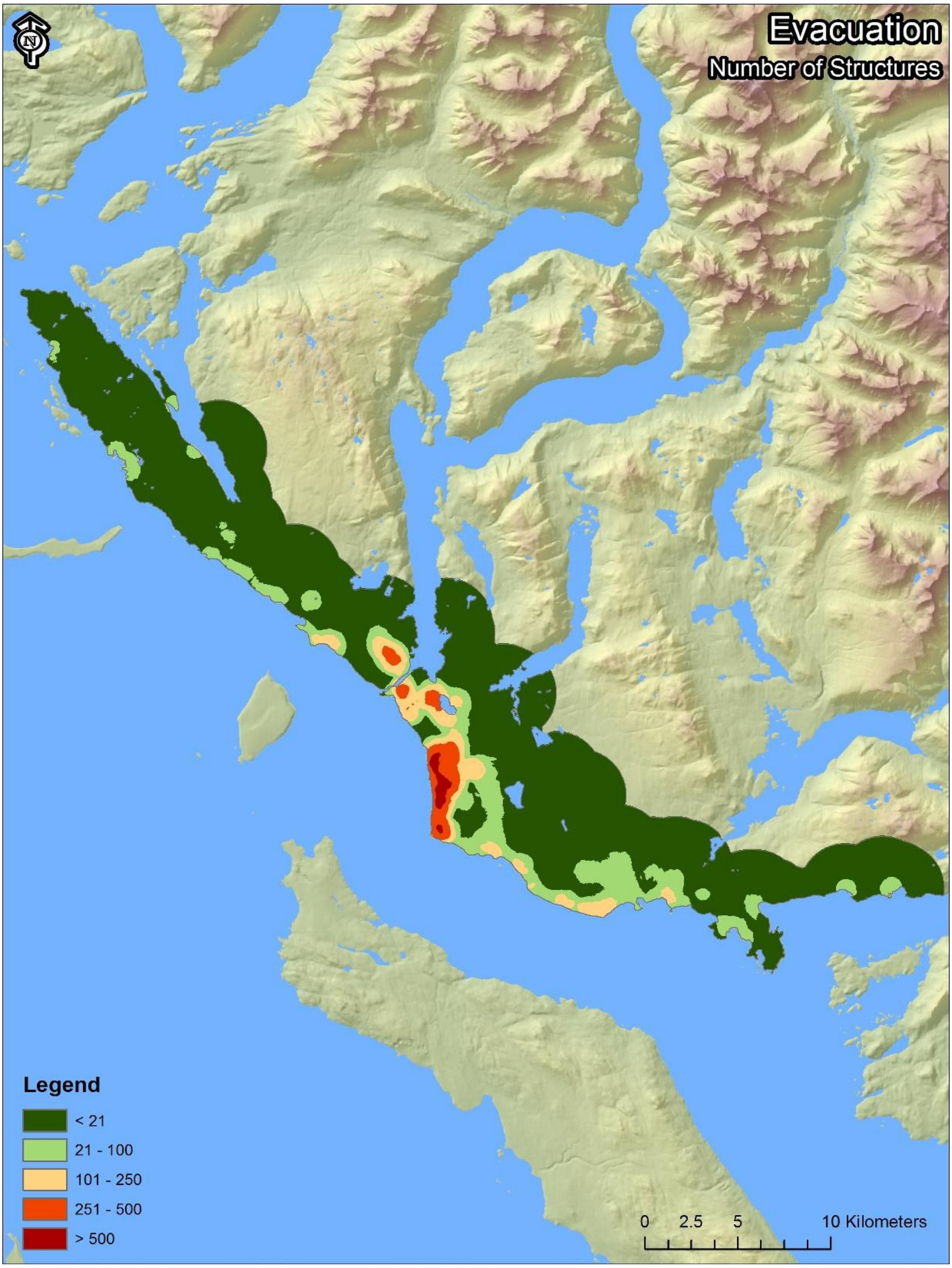


*This output illustrates how smoke dissipates seasonally (fire season) into the atmosphere. The period of July and August has fair to good venting for the study area; therefore concerns for smoke and smoke hazard are more limited. The greatest concern for air quality is during August (fire season peak) which is illustrated as fair to good (light orange colour) on the map.

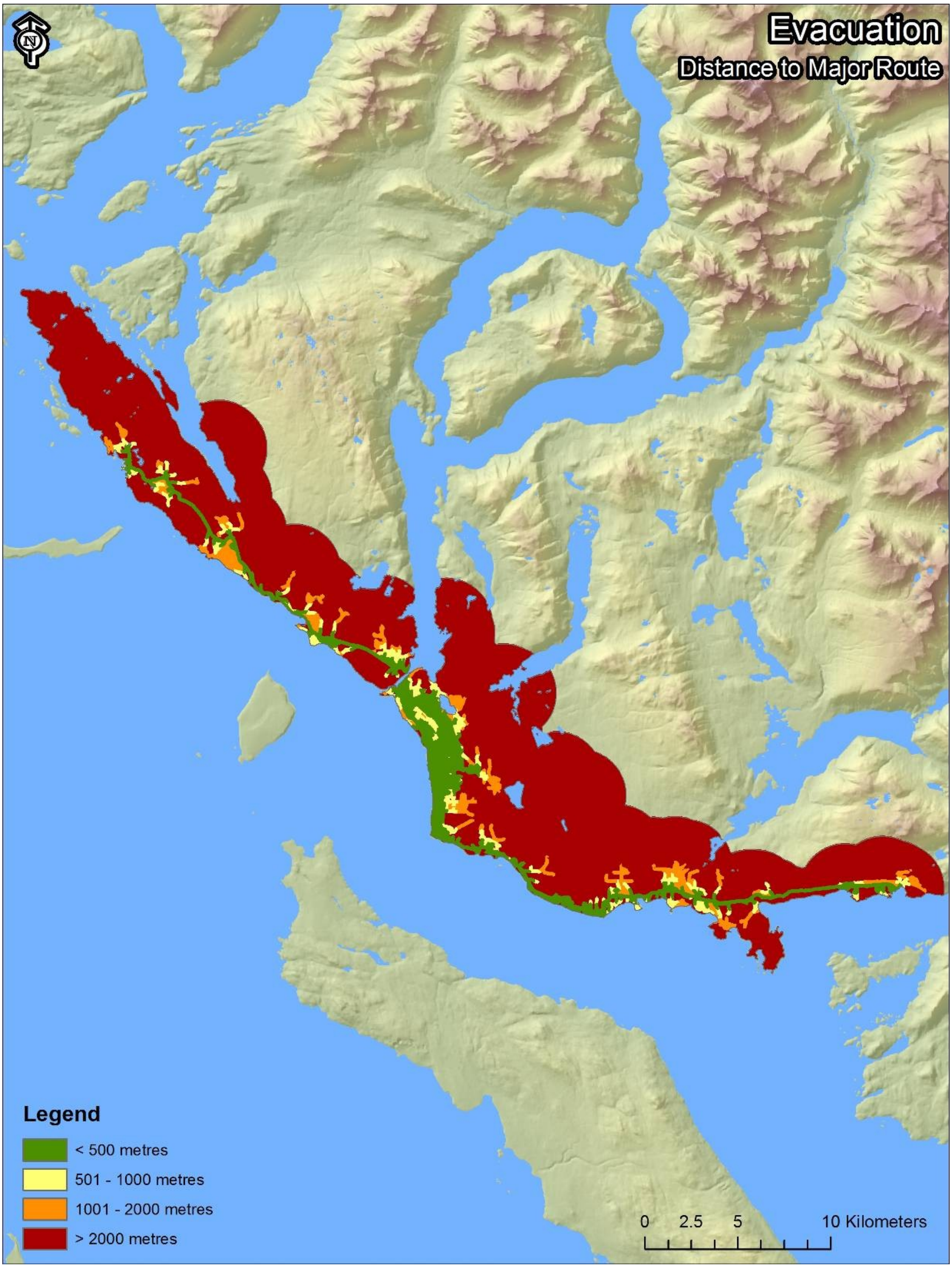
CONSEQUENCE: EVACUATION DIFFICULTY



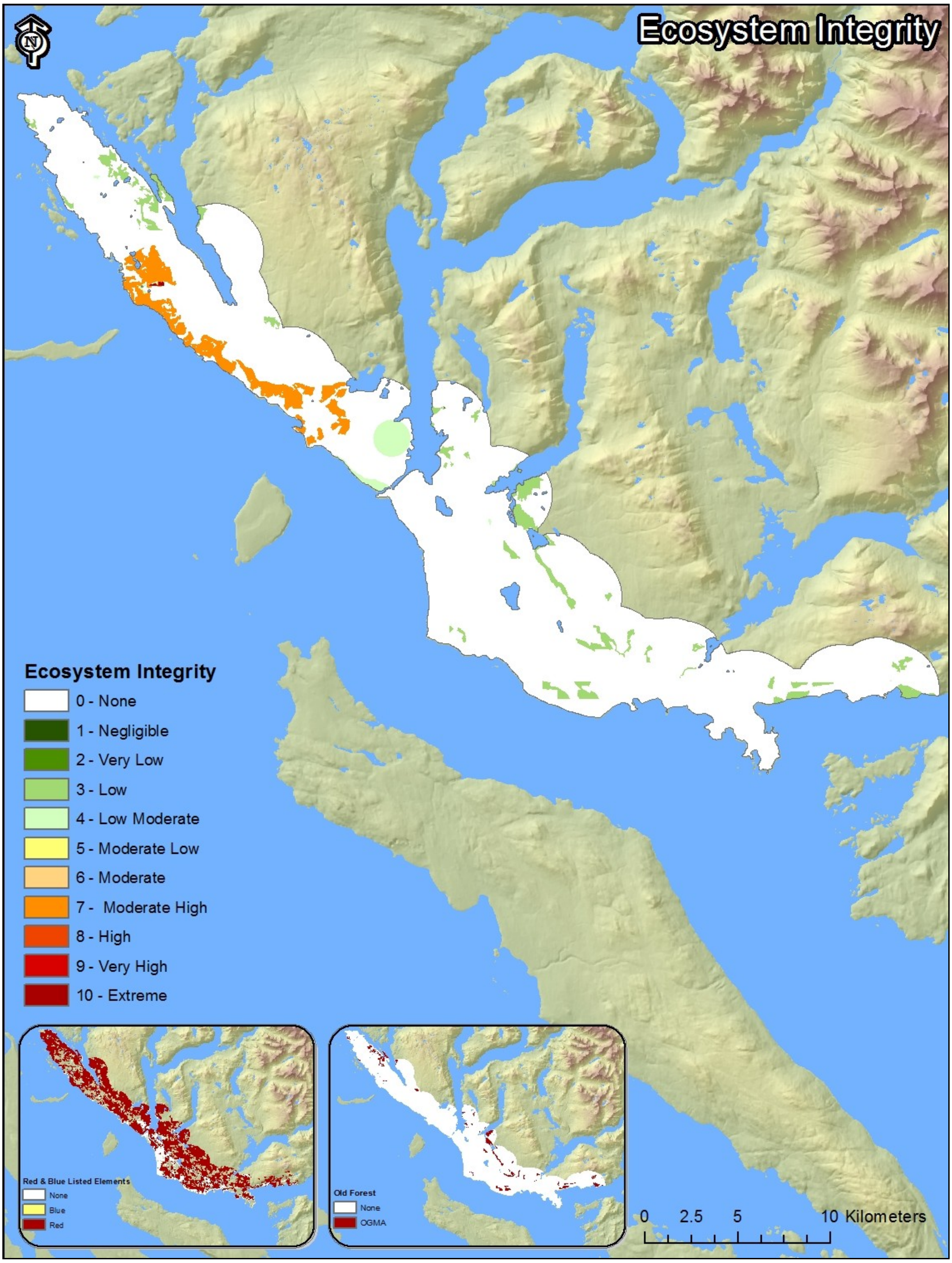
EVACUATION: NUMBER OF STRUCTURES



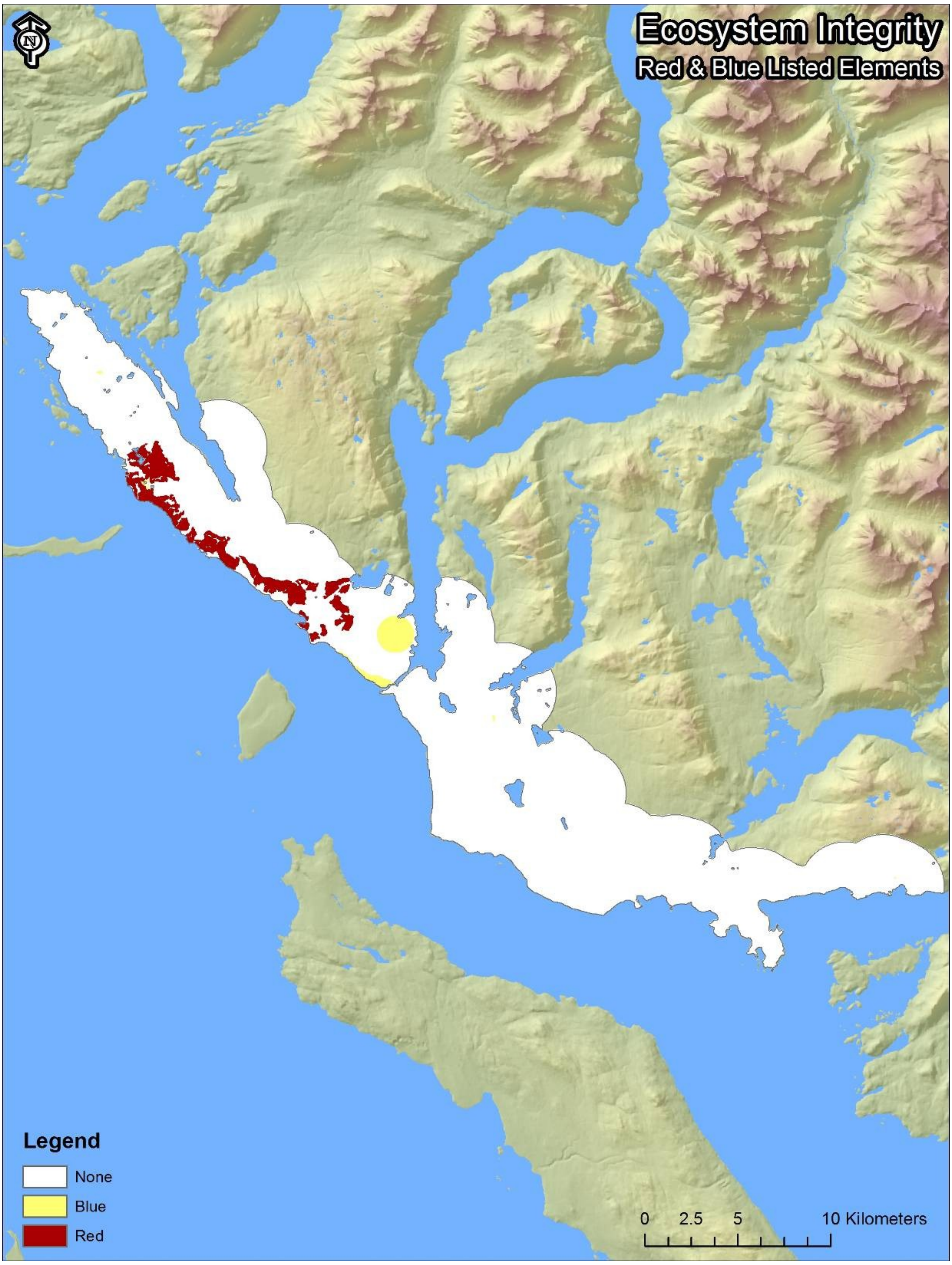
EVACUATION: DISTANCE TO MAJOR ROADS



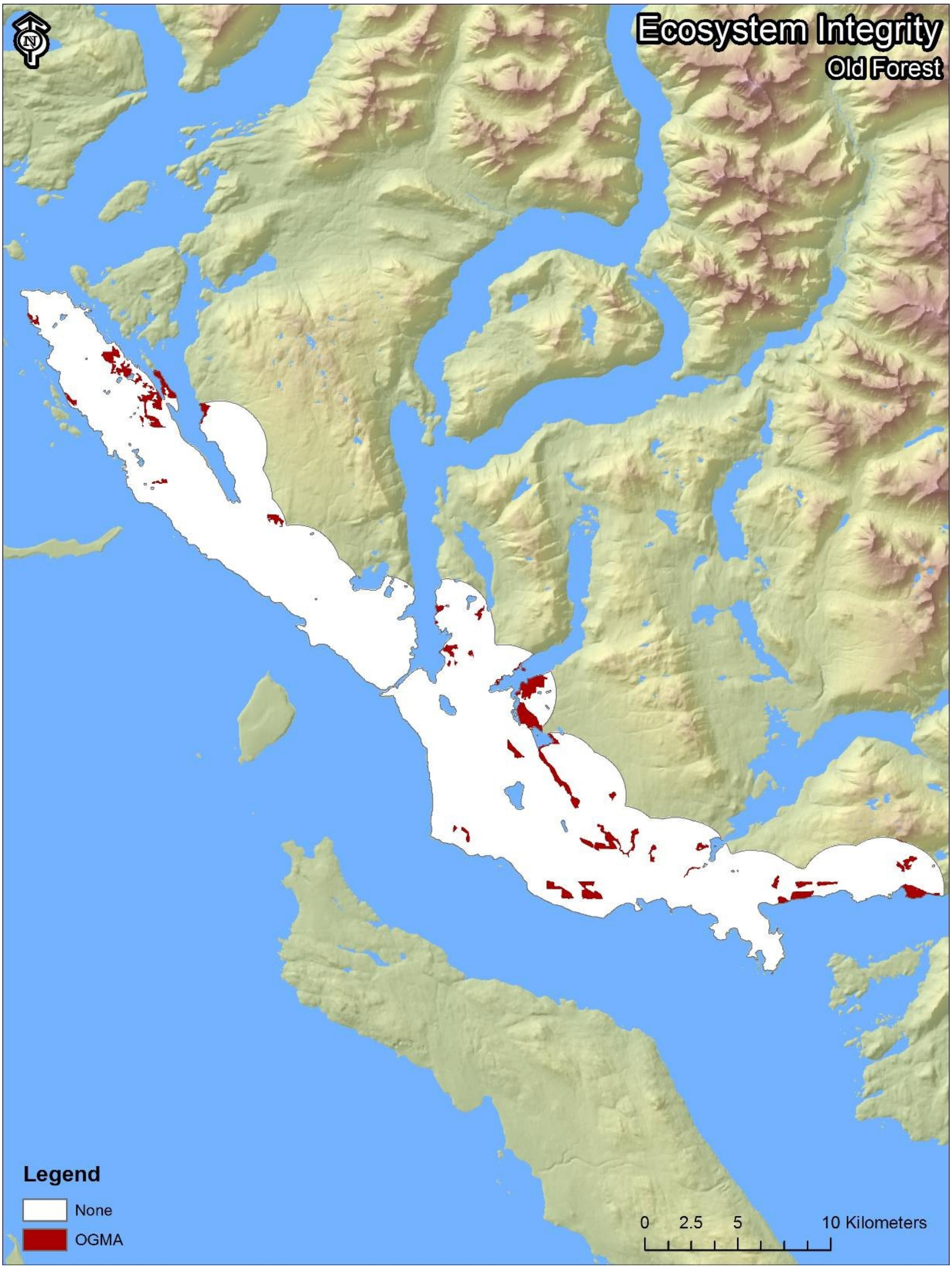
CONSEQUENCE: ECOSYSTEM INTEGRITY



ECOSYSTEM INTEGRITY: RED AND BLUE LISTED ELEMENTS



ECOSYSTEM INTEGRITY: OLD FOREST



APPENDIX B: FUEL TYPE SUMMARY

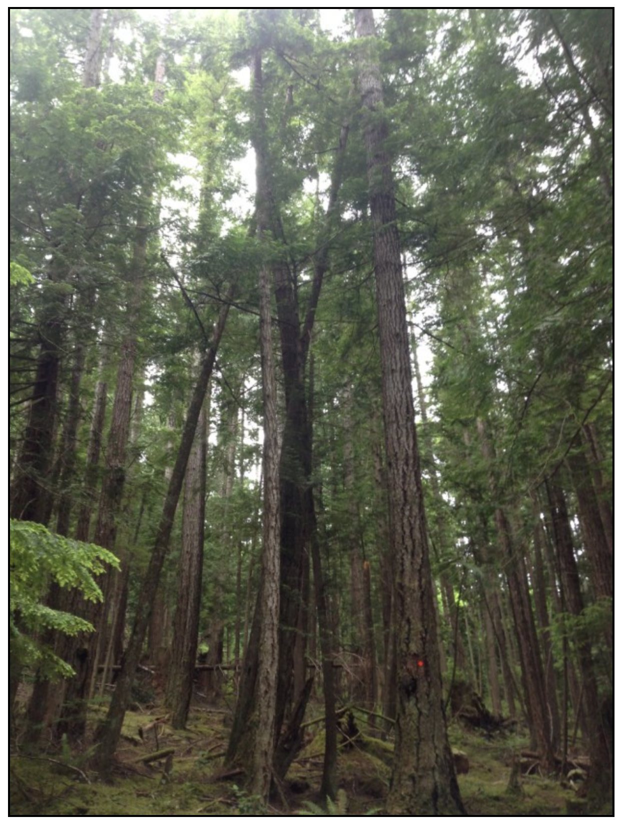
The fuel types considered hazardous in terms of dangerous fire behaviour and spotting (lofting burning embers) are C2, C4 and C3. Fuel type M2 can sometimes be hazardous depending on the proportion of coniferous trees in the stand, and time of year. Fuel types are summarized below.-

C2 Fuel Type

Fuels classified as C2 fuel types in the study area have the same relative fire behaviour and structural components as described in the FBP system but different species compositions. This fuel type structure classification was regeneration to pole sapling stands (10 – 25 years old), with more than 80% of the tree species coniferous type (Douglas-fir, western hemlock and western redcedar). These plantations can be mixed specie or single species. There is only a small portion of C2 fuel type located in the study area (0.8%), and the majority of it is located in TFL 39. This fuel type has high associated fire behaviour, with moderate burn difficulty (if fire is wind driven then there is a high potential for extreme fire behaviour and active crown fire). This fuel type is characterized by continuous crown and ladder fuels and supports crown fires. Surface fuel loading and understory vegetation are low, with high crown closure (>75%). Suppression in C2 types is difficult given the high fire intensity (intensity is a measure of fire energy released).

C3 Fuel Type

C3 is comprised of fully stocked, mixed species, young to mature forests (40 – 80 years) with few ladder fuels but generally high crown connectivity. The dominant species include Douglas-fir, western hemlock, and western redcedar, and tree species type is generally more than 80% coniferous. Crown closure can vary (40 – 100%), and surface fuel loading is generally low to moderate, with low to moderate understorey vegetation (depending on crown closure). This fuel type generally supports surface and crown fires, with a moderate burn difficulty; however, if fire is wind driven then there is a high potential for extreme fire behaviour and active crown fire. There is a moderate amount of C3 fuel type located throughout the study area (18.0%). Although scattered throughout the study area (including interface areas), the area northeast of Saltery Bay is predominantly C3 and a significant proportion occurs in TFL 39.



C4 Fuel Type

C4 is comprised of young forest (20 – 40 years) with moderate to high ladder fuels and moderate to high crown closure (40 – 80%). The dominant tree species include Douglas-fir, western hemlock and western redcedar, and tree species type is generally more than 80% coniferous. Surface fuel loading is moderate, with low to moderate understorey vegetation (depending on crown closure). These stands are generally mixed conifers, dense and almost always support surface and crown fire. Fire suppression in this fuel type can be extremely difficult. There is only a small portion of C4 fuel type in the study area (0.4%).

C5 Fuel Type

C5 fuels in the study area have the same relative fire behaviour and structural components as described in the FBP system but different species composition. C5 in the Regional District is characterized by mature (>80 years) Douglas-fir, western redcedar and western hemlock, and stands are predominantly of coniferous type (>80%). This fuel type is the most prevalent in the study area (32.3%) and is characterized by mature, well-spaced stands, with low to moderately dense understoreys. Tree crowns are well-separated from the ground. Crown fires are possible but are generally wind driven due the gappy nature of the canopy. Fire suppression efforts in this fuel type are heavily dependent upon topography and weather conditions.

C7 Fuel Type

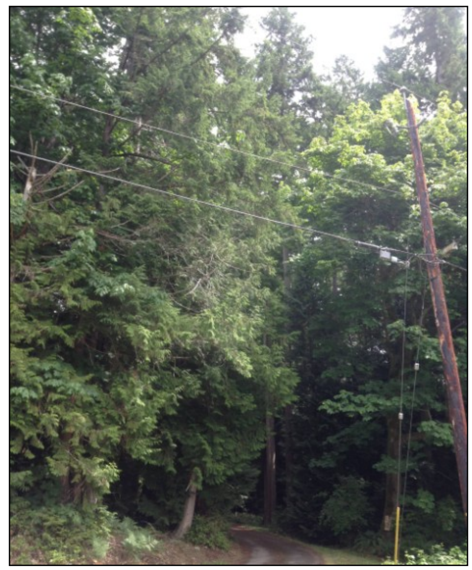
C7 fuel types are generally young to mature (20 – 80 years), uneven aged, open forests (crown closure 20 – 40%) that are predominantly coniferous (>80%), and the dominant tree species is Douglas-fir. This fuel type commonly has understorey vegetation with grass and other species that support surface fires, with moderate surface fuel loading. Approximately 2.2% of the fuels in the study area are C7 and they are scattered throughout the study area. Crown closure is low in these types with widely dispersed trees that make crown fires unlikely, although individual torching of trees can occur. This fuel type allows suppression crews to establish fire breaks.

D1 Fuel Type

D1 fuel types have been classified in this study as having more than 80% deciduous and the dominant tree species were red alder, bigleaf maple and aspen. The stands were pole sapling to mature (> 20 years), moderately well-stocked, with leaves, had high understorey vegetation with variable crown closure. Additionally, surface fuel loading was low to moderate and these stands generally have a high burn difficulty (difficult to burn). Fires that do occur in D1 fuel types are always low intensity surface fires. These areas are good options for creating fuel breaks in and around the community through conversion/conifer removal, if required. Stands with less than 10% conifer type would be ideal for fuel break consideration and would not require treatment. D1 fuel types extend throughout the Regional District, including various interface areas, and cover 7.7% of the study area.

M2 Fuel Type

M2 fuel types were typed as moderately well-stocked with mixed conifer and deciduous (no more than 80% conifer or deciduous), pole sapling to mature forest (>20 years), and with a variable understorey vegetation. Surface fuel loading is generally low to moderate with variable crown closure (40 – 100%) and a moderate burn difficulty. M2 stands under high fire danger can experience surface, torching and crowning, depending on the species composition. A total of 24.5% of the study area was typed as M2 and these areas occur throughout the Regional District, including in and adjacent to interface areas (*e.g*., Tla'amin Reserve #1 and the Saltery Bay area). These stands are ideal for fuel break consideration.



S3 Fuel Type

Fuels classified as S3 fuel types in the study area are the same as the FBP System and have the same relative fire behaviour and structural components, and species composition (coastal cedar-hemlock-Douglas-fir slash). This fuel type is characterized by continuous slash that is usually one season old, with high foliage retention for cedar and moderate for hemlock and Douglas-fir. There is generally heavy and deep slash loading from logging of mature stands, and there is low to moderate shrub and herb cover. These areas have a low burn difficulty and generally experience high to very high fire intensity and rate of spread under high fire danger, and are limited in the study area (3.7%).

O1 Fuel Types

Fuels classified as O1a (matted grass) in the study area are characterized by continuous, modified short grass (90% cured) and usually support rapid spreading, high intensity surface fires. O1b fuels (standing grass) are characterized by continuous, tall grasses and shrubs, and usually support rapid spreading, moderate intensity surface fire under high fire danger. O1 fuel types only covered a minor portion of the study area (1.5%).

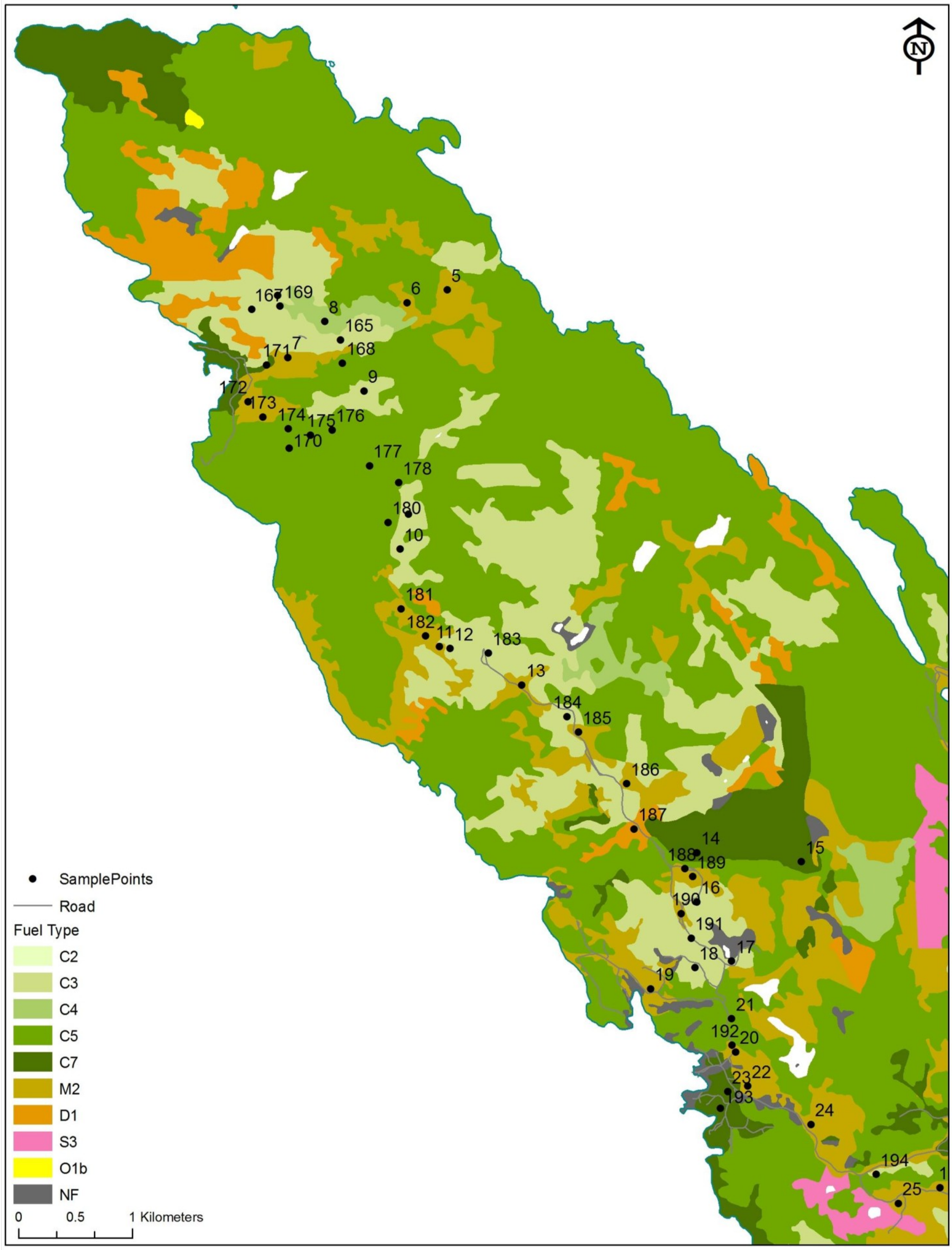
O1a matted grass.

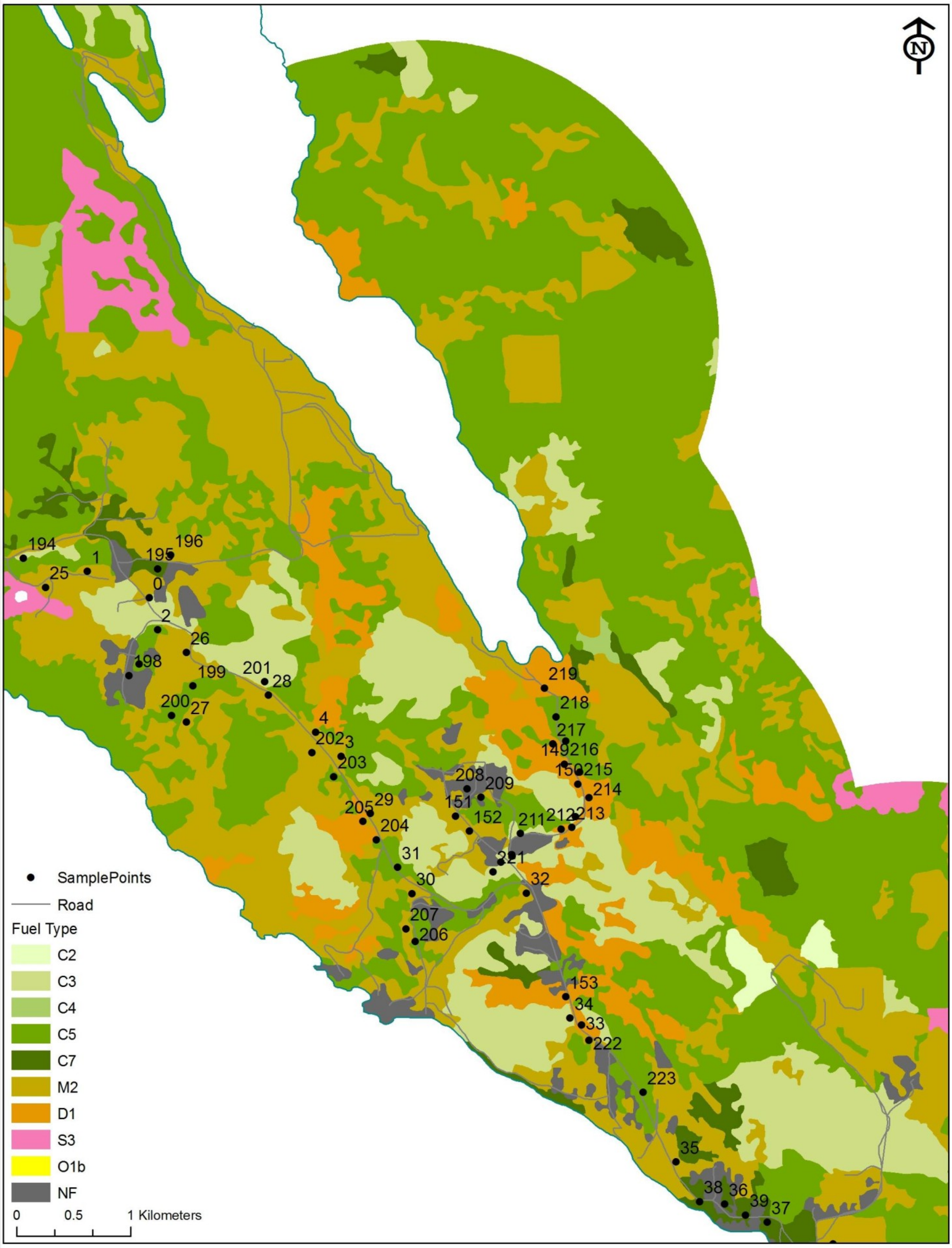
O1b standing grass

NF Fuel Types

Non-fuel includes areas such as gravel pits, cleared land or paved areas (communities) and account for 8.9% of the study area.

APPENDIX C: FIELD STOPS

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223
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38
36
39
37
SamplePoints
Road
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C3
C4
C5
C7
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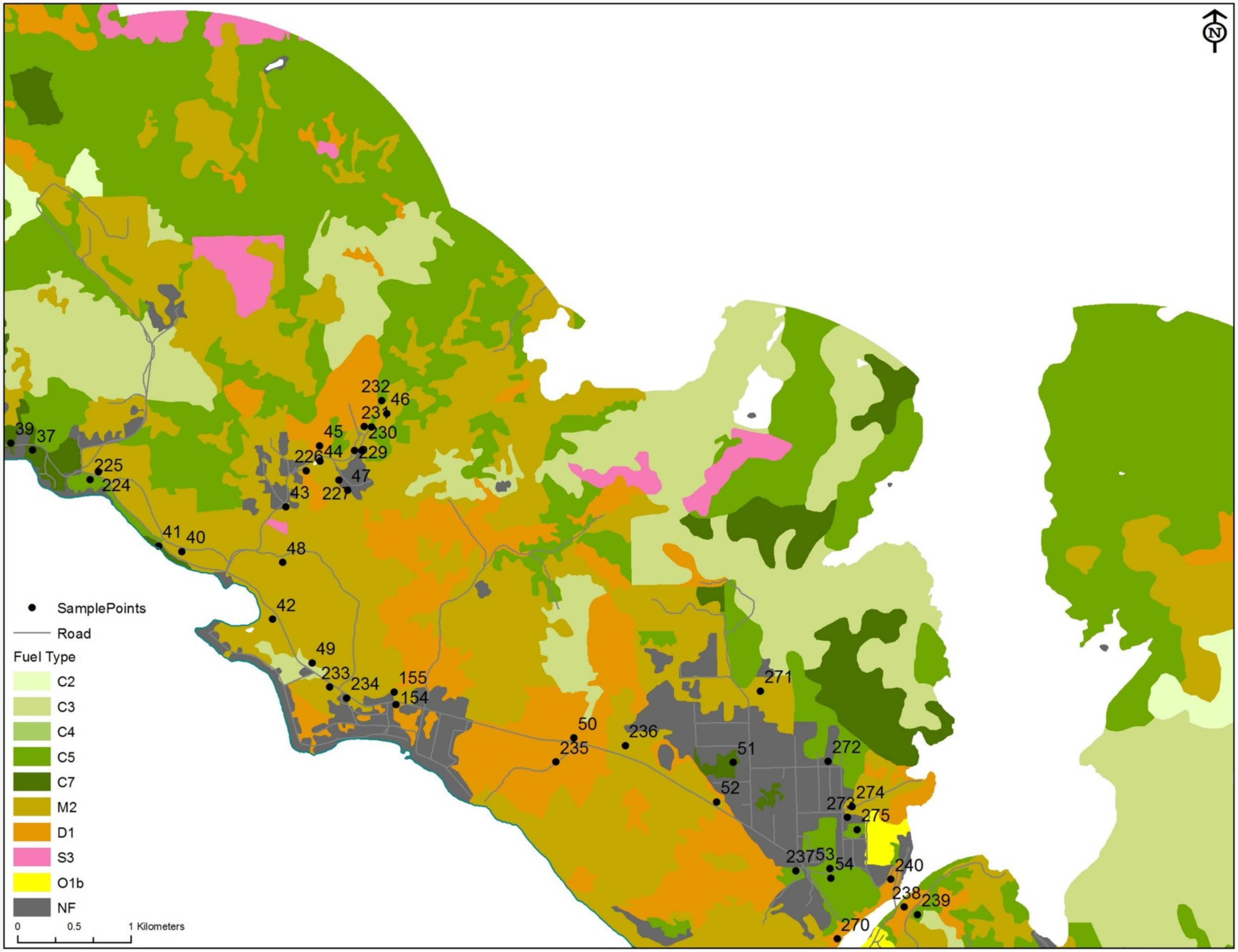
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Road
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C3
C4
C5
C7
M2
D1
S3
O1b
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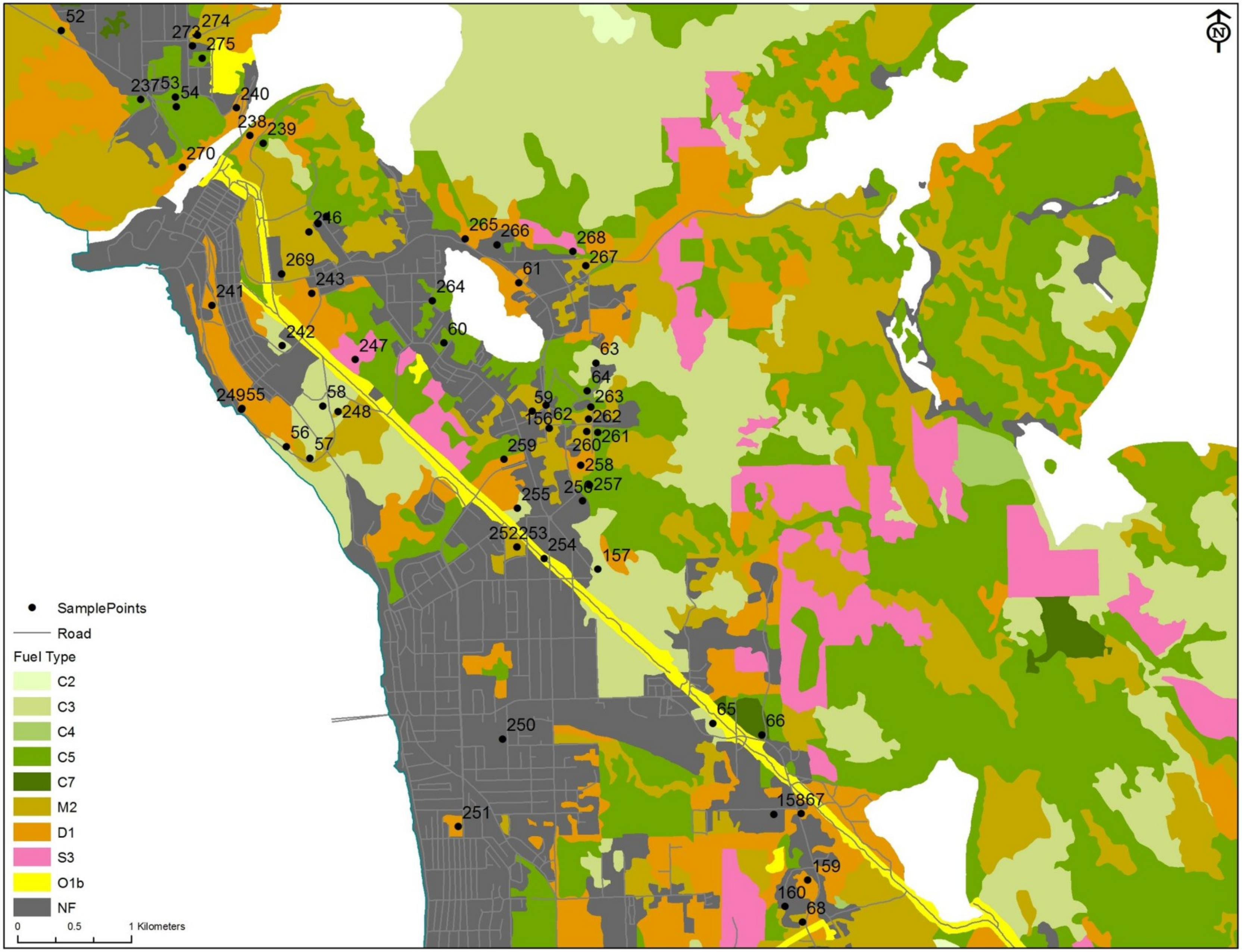
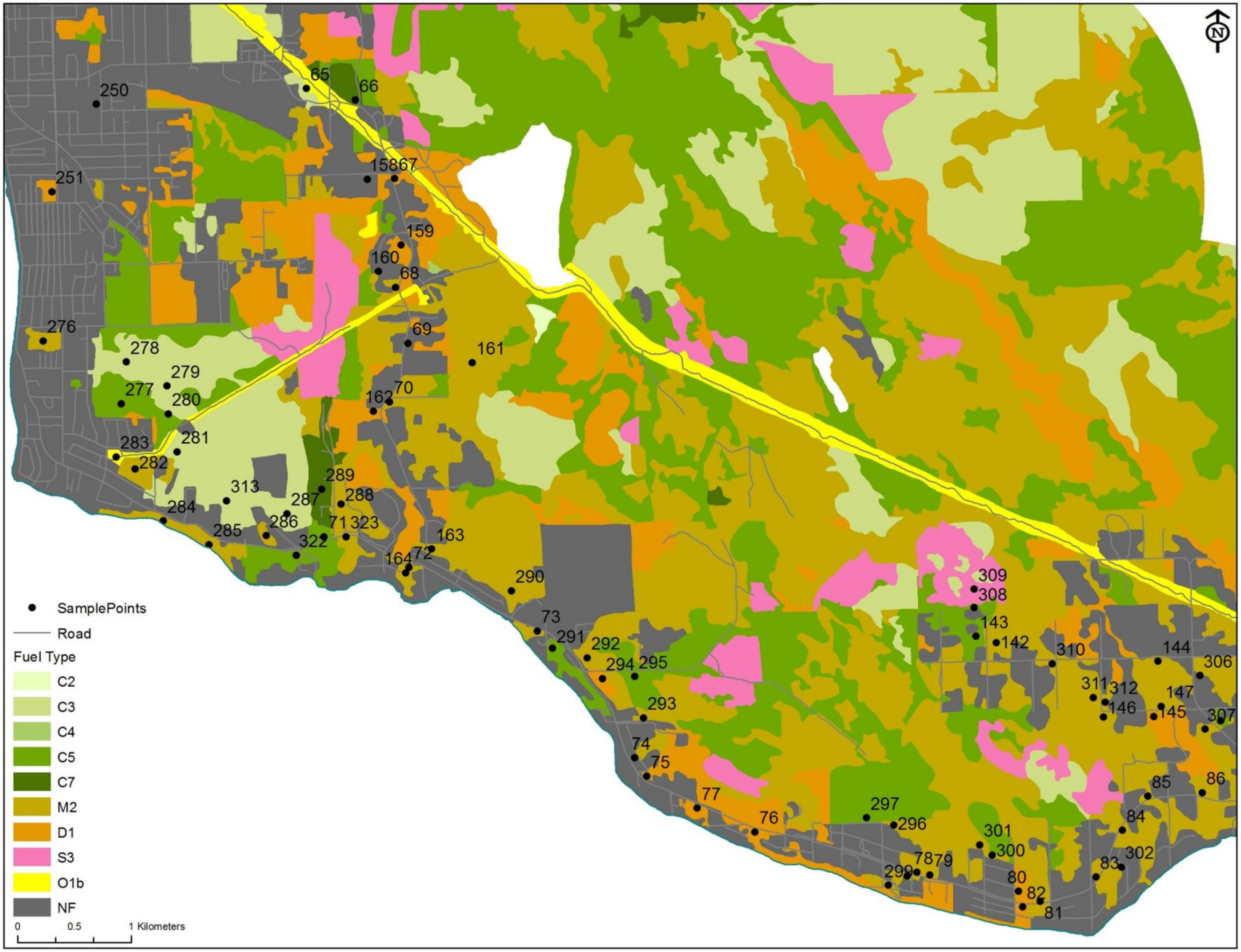

SamplePoints
Road
Fuel Type
C2
C3
C4
C5
C7
M2
D1
S3
O1b
NF
0
0.5
1 Kilometers
N


N
SamplePoints
Road
Fuel Type
C2
C3
C4
C5
C7
M2
D1
S3
O1b
NF
0 0.5 1 Kilometers
65
66
250
251
15867
159
160
68
69
161
276
278
279
277
280
162
70
283
281
282
289
288
313
287
284
286
71 323
285
322
163
164
72
290
309
308
143
142
73
291
292
294 295
310
144
306
311
312
146
147
145
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299
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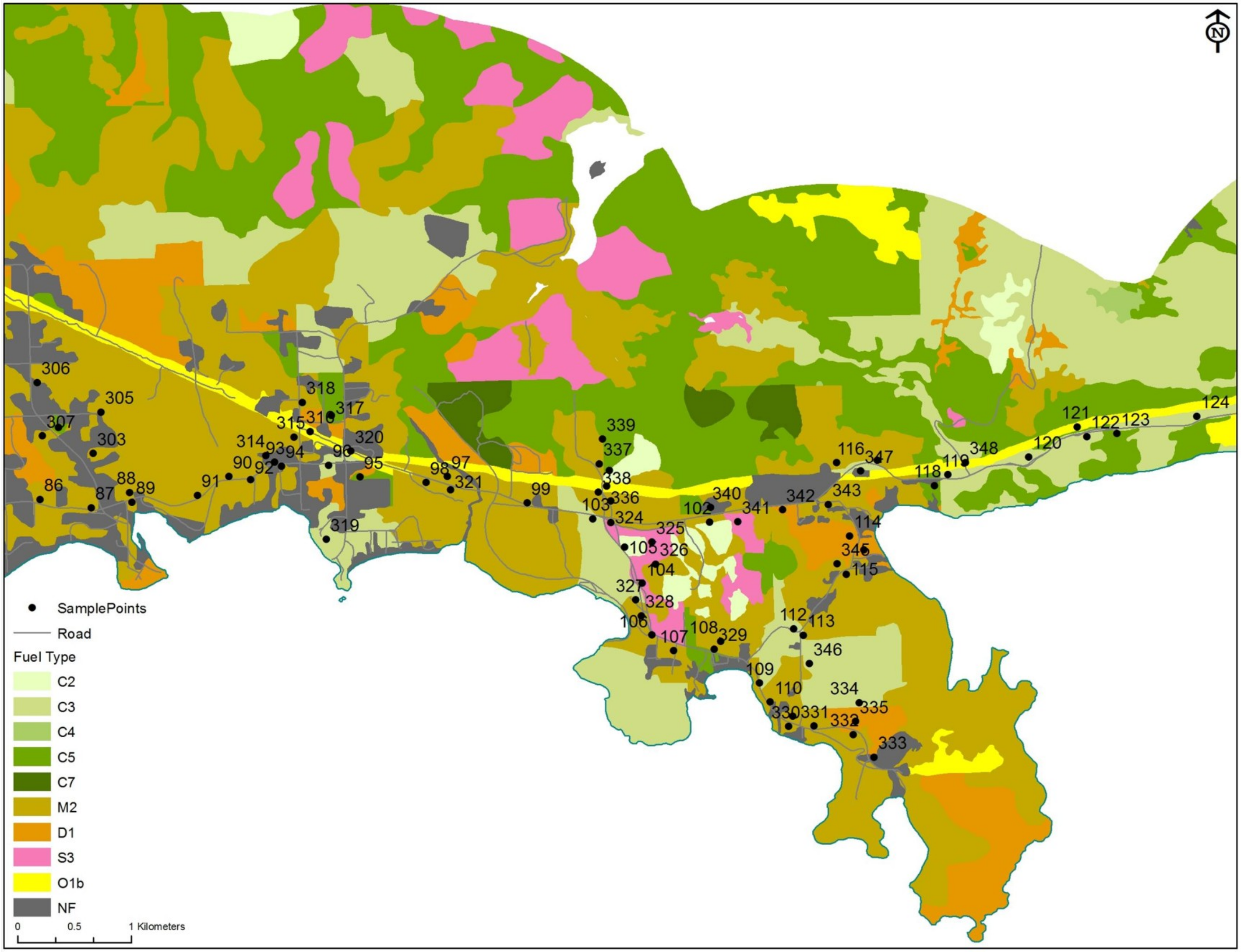
80
82
81


SamplePoints
Road
Fuel Type
C2
C3
C4
C5
C7
M2
D1
S3
O1b
NF
0
0.5
1 Kilometers
N

119
348
120
121
122
123
124
125
127
126
128
131
129
130
132
133
134
139
138
137
135
136
140
141
SamplePoints
Road
Fuel Type
C2
C3
C4
C5
C7
M2
D1
S3
O1b
NF
0
0.5
1 Kilometers

APPENDIX D: WRMS Weighting Sum Calculations

PROBABILITY: PROBABILITY OF IGNITION

Component Attributes:

Attribute	Indicator / Units	Rating Scale		Weight
Lightning Caused Fires *Indicator of historical frequency of lightning caused fires*		Extreme	10	25%
		High	7	
		Moderate	3	
		Low	0	
Human Caused Fires *Indicator of historical frequency of human caused fires*		Extreme	10	30%
		High	7	
		Moderate	3	
		Low	0	
Ignition Potential *Indicator of the potential for fire ignition based on fuel type and weather, calculated using WIPP (Wildfire Ignition Probability Predictor)*	Probability Class	Extreme	10	45%
		Very High	8	
		High	6	
		Moderate	4	
		Low	2	
		None	0	

Lightning Caused Fire	Kernel density per sq km of fire ignition points (1950 to 2011) and natural breaks (Jenks) density classes	ESRI Spatial Analyst
Human Caused Fire	Kernel density per sq km of fire ignition points (1950 to 2011) and natural breaks (Jenks) density classes	ESRI Spatial Analyst
Ignition Potential	Calculation based on fuel type and fire weather indices that incorporate regional climate and forest cover in estimating the likelihood of ignition.	Wildfire Ignition Probability Predictor

Databases: Historic Weather Station and Provincial Fire Data (MFLNRO); Provincial TRIM; Forest Fuel Types (Blackwell)
Uncertainties: climate change may lead to a change in lightning caused fires.

Lightning Caused Fires: Density analysis is used to classify the known ignition locations for the entire landscape. The result of this classification is a spatial surface showing the predicted distribution of the ignitions throughout the landscape. To produce smoothed density estimations for the study area, a kernel density classification, which summarizes number of events based on a search radius threshold, is applied. The resultant surface is split into four density classes described as low, moderate, high and extreme using natural breaks (Jenks classification method). Since the number of ignitions caused by humans is usually higher in occurrence density classes, human caused ignitions are generally used as the reference for the lightning caused ignitions.

Ignition Potential: Ignition potential is an indicator of the potential for fire ignition based on fuel type and 90th percentile fire weather conditions (historic fire weather encompassing 90% of the most extreme conditions recorded). It is calculated using the Wildfire Ignition Probability Predictor (WIPP). The model determines the probability of sustained ignition from simulated human-caused fire brands (matches and camp fires) and predicts, in broad classes ("no-fire day" less than 50% probability of sustained ignition and "fire day" greater than 50% probability), from readily available indicators of fire danger based on benchmark fuel type groups. Ignition probability is expressed on an area basis provided a measure of human-caused fire potential from simple fire danger rating system components.

Probability of Ignition Component: The overall probability of ignition is derived by multiplying the ratings for human caused ignitions, lightning caused ignitions, and the ignition potential by their respective weights to get an ignition probability rating out of 10.

PROBABILITY: POTENTIAL FIRE BEHAVIOUR

Component Attributes:

Attribute	Indicator / Units	Rating Scale		Weight
Fire Intensity *Indicator of the rate of heat energy released.*	kilowatts per metre	> 30,000	10	50%
		10,001 - 30,000	8	
		4,001 - 10,000	6	
		501 - 4,000	4	
		1-500	2	
		0	0	
Rate of Spread *Indicator of speed at which fire extends horizontally.*	metres per minute	> 40	10	25%
		21 - 40	8	
		11 - 20	6	
		6 - 10	4	
		1 - 5	2	
		0	0	
Crown Fraction Burned *Indicator of the proportion of tree crowns consumed by fire (i.e., a measure of tree mortality).*	%	76 - 100	10	25%
		51 - 75	8	
		21 - 50	6	
		11 - 20	4	
		1 - 10	2	
		0	0	

Databases: Provincial TRIM; Provincial VRI; Historic Weather Station Data (MFLNRO); Forest Fuel Types (Blackwell); Provincial BEC.

Fire Intensity	Calculation using fire weather data, fuel type and topography (slope, aspect etc).	CFS Fire Behaviour Predictor 97
Rate of Spread	Calculation using fire weather data, fuel type and topography (slope, aspect etc)	CFS Fire Behaviour Predictor 97
Crown Fraction Burned	Calculation using fire weather data, fuel type and topography (slope, aspect etc)	CFS Fire Behaviour Predictor 97

The fire behaviour component estimates how wildfire would behave under 90th percentile historic weather conditions chosen from the climate record for the study area. Spatial station location and elevation are used to derive lapse rates that result in gradients of temperature and relative humidity that are more realistic across the landscape. The 90th percentile fire weather from each weather station contributes to fire behaviour depending on its proximity to any given point in the landscape. An elevation dependent lapse rate is used to adjust the fire weather values from each station and this, with slope, is used to calculate fire behaviour.

Fire weather, stand-level fuel types, slope and aspect are then processed through the FBP97 (Fire Behaviour Predictor 1997) program. Fire Behaviour Predictor 97 is a Windows™ based version of the Canadian Fire Behaviour Prediction System (Forestry Canada Fire Danger Group 1992) developed by Remsoft Inc. The fire behaviour outputs of FBP97 include: fire intensity, rate of spread, and crown fraction burned.

Fire Intensity: The fire intensity is a measure of the rate of heat energy released per unit time per unit length of fire front. It is based on the rate of spread and predicted fuel consumption of the fire, and is expressed in kilowatts per meter (Pyne 1984).

Rate of Spread: The rate of spread is a measure of the speed at which fire expands its horizontal dimensions at the head of the fire. This is based on the hourly Initial Spread Index (ISI) value and is expressed in meters per minute. The rate of spread is adjusted for steepness of slope and interactions between slope direction and wind direction determined from the Build-Up Index (BUI).

Crown Fraction Burned: The crown fraction burned is a measure of the proportion of the tree crowns consumed by fire and is expressed as a percentage value. It is based on rate of spread, crown base height and foliar moisture content.

Potential Fire Behaviour Component: The potential fire behaviour is derived by multiplying the ratings for fire intensity, rate of spread, and crown fraction burned by their respective weights to get an ignition probability rating out of 10.

PROBABILITY: SUPPRESSION CAPABILITY

Component Attributes:

Attribute	Indicator / Units	Rating Scale		Weight
Constraints to Detection *Indicator of the ability to detect a fire: reconnaissance at higher elevations is often constrained by cloud cover.*	elevation metres	> 500	10	10%
		250 - 500	7	
		100 - 250	3	
		0 - 100	0	
Proximity to Water Sources *Indicator of the ability to access water quickly for fire fighting. Based on distance from all season streams and lakes.*	distance metres	>300	10	10%
		101-300	7	
		0-100	2	
Air Tanker Arrival Time *Indicator of time for air tanker action measured as flight time (concentric) from nearest tanker base (300k/hr)*	minutes	> 40	10	20%
		31 - 40 (200km)	7	
		21 - 30 (150km)	5	
		11 - 20 (100km)	3	
		0 - 10 (50km)	0	
Helicopter Arrival Time *Indicator of the time for initial attack, measured as flight time (concentric) from nearest base PLUS fixed assumptions about time of travel to the base.*	minutes	> 70	10	20%
		51 - 70 (210 km)	7	
		31 - 50 (150 km)	5	
		11 - 30 (90 km)	3	
		0 - 10 (30 km)	0	
Terrain Steepness *Indicator of the difficulty of control/contain on the landscape.*	slope Class %	> 60	10	30%
		41 - 60	7	
		21 - 40	3	
		0 - 20	0	
Proximity to Roads *Indicator of the ability to get suppression resources into an area: based on a bush walking rate of 1 km / hour.*	minutes	> 120 (>2km)	10	10%
		61 - 120 (2 km)	7	
		31 - 60 (1km)	5	
		16 - 30 (0.5km)	3	
		0 -15 (0.25km)	0	

Databases: Provincial TRIM; Elevation; Road Atlas; Provincial Water Layer; WMB Air Tanker Base/Helicopter Locations.

Constraints to Detection	Average elevation above valley bottom of forest inventory polygon
Proximity to Water Sources	Buffer distance from determinant streams and lakes
Air Tanker Arrival Time	Measured flight time (concentric) from air tanker base
Helicopter Arrival Time	Measured flight time (concentric) from heli base
Terrain Steepness	Average slope of forest inventory polygon
Proximity to Roads	Buffer distance from roads

Constraints to Detection: In BC, fires are detected by three primary methods that include a Provincial lightning location system, aircraft and/or by the public. Due to the unpredictability of flight frequency and public response, it was not possible to quantify the speed of detection. Detection is primarily a function of visibility limitations associated with high elevation cloud in specific parts of the study area. A storm front with varying amounts of precipitation typically follows an active lightning period. This storm front would create cloud and fog within higher elevations zones of the study area during a 12 to 24 hour period following the storm. This cloud and fog cover inhibits the critical detection period, considering most fire ignitions within the study area occur during the transition from a high to low-pressure weather system. Constraints to the detection subcomponent were therefore based on elevation classes. The higher the elevation, the more likely detection will be constrained by cloud and fog cover. Elevation classes are varied by study area depending on the community elevation.

Proximity to Water Sources: Proximity to ground water sources (pumpable water) are delineated using the hydrological base data (only includes perennial water sources), hydrants and water tanks. Proximity to water sources for fire suppression (an indicator of the ability to access water quickly for firefighting) is evaluated by creating a 100 m and 300 m buffer around these water sources. Areas outside of the 300 m buffer are given the maximum subcomponent rating. It is important to note that a complete spatial database of hydrant locations does not currently exist for the Regional District. Additionally, the ocean is not considered a viable ground water source considering only fresh water sources can be used with the structural fire suppression equipment. The ocean can be used as a water source with wildfire suppression equipment however this was not considered in proximity to water sources.

Air Tanker Arrival Time: The air tanker arrival time subcomponent is determined based on the distance from the closest base to the study area. The ratings increased with greater distance from the base.

Helicopter Arrival Time: The helicopter arrival time subcomponent is determined based on the distance from the closest base to the study area. The ratings increased with greater distance from the base.

Terrain Steepness: Steepness of terrain influences the ability of a ground crew to build fireguards and carry out ground suppression. Average slope class is determined from the terrain data and ratings are assigned according to slope class.

Proximity to Roads: Proximity to active roads is used to evaluate the ability of suppression resources to reach areas within a study area. It is evaluated based on a bush-walking rate of 1 km/hr. Proximity to roads is rated by creating buffers around all active roads in the study area and assigning weights relative to walking time from these areas.

Suppression Capability Component: The Suppression Capability is derived by multiplying the ratings for each subcomponent by their respective weights to get an ignition probability rating out of 10.

CONSEQUENCE: URBAN INTERFACE

The consequence themes vary by study area but interface density and air quality are always included. Consequence subcomponents and components are calculated in the same way probability components are and given that they vary between communities, we will not describe every component here. The 'Component Templates' provides adequate information to interpret each layer. Interface density and air quality are described below.

Component Attributes:

Attribute	Indicator / Units	Rating Scale		Weight
Interface Density *Indicator of threat to private and public property. Density class (from TRIM) = Build-up areas and # of structures/km*2*	Weight by density class	Urban	10	50%
		Developed	9	
		Mixed	7	
		Undeveloped	5	
		Isolated	2	
		None	0	
Recreation Use *Indicator of the threat to recreation use area (trails, provincial and municipal parks)*	Distance from recreation areas	distance < 0.5 km	10	10%
		0.5 km < distance < 1km	7	
		1 km< distance < 5 km	2	
		distance > 5 km	0	
Drinking Water Sources *Special features identified within the study area and rated as extreme*	Watersheds and 100 m buffer arround PODs	Watersheds and PODs	10	20%
		None	0	
Visual Quality *Indicator of the visual quality rating for Visual Sensitivity Units as delineated from important local vantage points.*	Visually Sensitive	Visually Sensitive	10	20%
		None	0	

Databases: Provincial TRIM; Provincial Cadastral (corrected with orthophotos); Road Atlas; Provincial VRI; Community Watersheds (LRDW)

Interface Density	Indicator of threat to private and public property. Kernel Density of the structures per sq km and classes
Recreation Use	Indicator of threat to high value recreation areas which includes trails and parks
Drinking Water Sources	Buffer distance around watersheds and Points of Diversion (PODs)
Visual Quality	Indicator of the visual quality rating for Visual Sensitivity Units as delineated from important local vantage points.

Interface Density: The interface density subcomponent is an indicator of threat to structures and is based on the density of structures within a study area (number of structures/km^2).

CONSEQUENCE: AIR QUALITY

Component Attributes:

Attribute	Indicator / Units	Rating Scale		Weight
Proximity to Population Centres *Indicator of the distance to populated areas.*	distance (D) kilometres	D <=500 m	10	30%
		1 km > D > 500 m	9	
		2 km > D > 1 km	7	
		5 km > D > 2 km	5	
		10 km > D > 5 km	3	
		25 km > D > 10 km	1	
		D > 25 km	0	
Smoke Production Potential *Indicator of the potential for smoke production as a function of seral stage (overall biomass, forest floor depth, etc.)*	N/A	Old & Mature	10	20%
		Young	7	
		Old & Mature MH	5	
		Pole Sapling	3	
		Shrub / Herb	0	
Smoke Venting Potential *Indicator of the potential for smoke dispersion based on the mixing height during poor ventilation index days*	by elevation (E) metres	height < 500m	10	30%
		500m > H > 750m	7	
		750m > H > 1000m	4	
		H > 1000m	1	
Monthly Smoke Venting Potential *Indicator of the potential for smoke dispersion based on month*	by month	Jan	10	20%
		Nov, Dec	9	
		Feb	8	
		Sept, Oct	7	
		Aug	6	
		Mar	4	
		May	3	
		Jun, July	2	
		Apr	1	

Databases: Provincial Cadastral (corrected with orthophotos); Provincial VRI

Proximity to Population Centers	Buffer distance from urban interface
Smoke Production Potential	Smoke production as a function of seral stage (i.e., biomass)
Smoke Venting Potential	Average elevation above valley floor of forest inventory polygon
Monthly Smoke Venting Potential	Monthly smoke dispersion rating based on long-term averages (Ambient Air Quality Data adapted from Vancouver Regional Air Quality Specialist)

CONSEQUENCE: EVACUATION

Component Attributes:

Attribute	Indicator / Units	Rating Scale		Weight
Number of Structures *Count of structures within an 'egress catchment', defined as an area containing one or more roads that connect to a major route. Egress catchments created using 100 m buffers around structures.*	Count of structures	> 500	10	30%
		251 - 500	8	
		101 - 250	6	
		21 - 100	3	
		< 21	1	
Distance to Major Route *Distance evacuee has to travel from there house to a major route*	Metres	> 2000	10	70%
		1001 - 2000	7	
		501 - 1000	5	
		< 500	2	

Databases: Provincial Cadastral (corrected with orthophotos); Road Atlas

Number of Structures	Count of structures within an 'egress catchment' defined as an area containing one or more roads that connect to a major route. Egress catchments were created using 100 m buffers around structures.
Distance to Major Route	Distance evacuee has to travel from their home to a major route.

CONSEQUENCE: ECOSYSTEM INTEGRITY

Component Attributes:

Attribute	Indicator / Units	Rating Scale		Weight
Red & Blue Listed Elements *Indicator of the threat to CDC Red & Blue Listed species & ecosystems*		Red	10	70%
		Blue	5	
		Other	0	
Old Forest *Indicator of the threat to the old forest*		OGMA	10	30%

Databases: Conservation Data Centre; Legal and Non-Legal OGMAs (LRDW).

Red & Blue Listed Elements	Indicator of the threat to CDC Red and Blue listed species and ecosystems
Old Forest	Indicator of the threat to Old Growth Management Areas

OVERALL PROBABILITY AND CONSEQUENCE RATING SUMMARIES:

Consequence Rating		Attribute Rating	Attribute Weight	Weighted Sum	Component Weight	Weighted Sum
Urban Interface	Interface Density		50%			
	Recreation Use		10%			
	Drinking Water Sources		20%			
	Visual Quality		20%			
					50%	
Air Quality	Proximity to Population Centres		30%			
	Smoke Production Potential		20%			
	Smoke Venting Potential		30%			
	Monthly Smoke Venting Potential		20%			
					20%	
Evacuation	Number of Structures		30%			
	Distance to Major Route		70%			
					20%	
Ecosystem Integrity	Red and Blue Listed Elements		70%			
	Old Forest		30%			
					10%	
					Consequence Rating	

Attribute ratings derived from GIS databases
Weights assigned by technical planning committee
Weighted Sums calculated and plotted in GIS

MODEL ASSUMPTIONS AND LIMITATIONS:

It is worthy to note that all models are simplified representations of complex systems and therefore have inherent limitations and assumptions. The weightings and ratings are subjective and based on professional judgments formed through extensive experience in past applications of the model. The greatest limitation with the model is the data used. The WRMS has some sensitivity to data errors, particularly in heavily weighted subcomponents; however due to its additive nature, errors in data will not drastically lower or increase the risk estimate unless they are prevalent throughout the majority of components and in the most heavily weighted components. The WRMS is an additive model that outputs a conservative assessment of risk. The Fire Behaviour Prediction system is used to derive the fire behaviour component, and the WRMS is subject to the limitations and assumptions of this sub-model. The model does not make projections for change over time; it is a snapshot of the current conditions within the study area and is therefore only valid while there are minimal changes in the landscape.