WORKSHOP ON SALMON WATERSHED RECOVERY IN POST-WILDFIRE ENVIRONMENTS: FROM THEORY TO PRACTICE

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Down to Earth Biology

EXECUTIVE SUMMARY

Wildfire size and severity and the annual area burned have been increasing, to unprecedented levels in recent years, across much of western North America including British Columbia (BC). In BC, the uncharacteristically large wildfires that occurred between 2017 and 2021 mostly occurred in upper and middle Fraser River subbasins which are critical spawning and rearing areas for Pacific salmon and year-round habitat for many other socially and economically important species. In 2018, large wildfires also occurred along the Stikine River (northwestern BC), which is also an important migratory route for Pacific salmon, and in BC's far-north Arctic subbasins.

Responses to major wildfires are usually geared towards managing the health and safety of people and to protecting valued natural resources and infrastructure. In comparison, little attention has been directed towards understanding how major wildfires in BC affect fish and fish habitat and what the response to major wildfires should be from the perspective of protecting, managing and restoring fish habitat. British Columbia does not have a strategic plan, or 'Playbook', for management actions that aim to mitigate impacts and accelerate the recovery of watersheds and salmon habitat following catastrophic wildfires.

The Pacific Salmon Foundation's (PSF) first step in the development of the *Playbook to Guide Landscape Recovery Strategies & Priorities for Salmon Habitat Following Major Wildfires* (the Playbook) was to host a one-day webinar called *Workshop on Salmon Watershed Recovery in Post-Wildfire Environments: From Theory to Practice.* It took place on January 26, 2022. The workshop brought together scientific and technical experts and a network of engaged First Nations, government agencies, stakeholders and non-governmental organizations to explore the impacts and risks to salmon and salmon habitat that are posed by catastrophic wildfires and to consider a collective response.

The key objectives of the workshop were to:

- convey and transmit knowledge on wildfire impacts to salmon habitat and on mitigation, techniques, and watershed recovery strategies;
- provide opportunities for discussion;
- provide an overview of PSF's Playbook project;
- contribute toward the development of a "Wildfire Recovery Community;" and,
- identify individuals and organizations and governments who/that should be involved in the development of the Playbook.

Over 200 participants representing federal, provincial and Indigenous agencies, industry, academia, non-governmental organizations, and community members attended the workshop. This document provides a summary of the workshop presentations and discussions, and highlights some of the key questions that were raised by the attendees and expert panels.

FINANCIAL SUPPORT

The Workshop was a component of a larger projected titled *Playbook to Guide Landscape Recovery Strategies & Priorities for Salmon Habitat Following Major Wildfires.* It was funded by a joint federal/provincial British Columbia Salmon Restoration and Innovation Fund grant to the Pacific Salmon Foundation.

THE PROCEEDINGS TEAM

Jeff Morgan and Jason Hwang of the Pacific Salmon Foundation developed the vision for this workshop, organized the workshop and then delivered it. Both provided senior-level review of draft versions of the Proceedings.

Oh Boy Productions managed the technical aspects of the workshop including question-answer management and the recording of presentations and panel discussions.

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ACRONYMS AND ABBREVIATIONS

Acronym/ Abbreviation	Definition
AU	multi-scale assessment units
BAER	burned area emergency response
BC FLNRORD	British Columbia Ministry of Forests, Lands, Natural Resources Operations and Rural Development
BC MOTI	British Columbia Ministry of Transportation and Infrastructure
BC SRIF	British Columbia Salmon Restoration and Innovation Fund
BDA	beaver dam analog
BMP	best management practice
CP	chronological pairing
ERP	emergency response plan
ESI	Environmental Stewardship Initiative
ESR	emergency stabilization & rehabilitation
FN	First Nations
FP	frequency pairing
FRPA	Forest & Range Practices Act
FTE	full-time employment
GIS	Geographic Information System
G2G	government-to-government
ha	Hectare
IK	Indigenous knowledge
IT	Indigenous tradition
LAT	landscape analysis tool
LFH	Duff and litter layers of forest soils
Lidar	light detection and ranging
NGO	non-government organization
OM	organic matter
PBR	process-based restoration
PFB	passive environmental factors
PNW	Pacific Northwest
PSF	Pacific Salmon Foundation
QR code	quick response code
SERNbc	Society for Ecosystem Restoration in Northern British Columbia
SRSS	Secwepemcúl'ecw Restoration and Stewardship Society
TSA	timber supply area

UBC	University of British Columbia
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples
US	United States
USDA	United States Department of Agriculture
WRI	Utah's Watershed Restoration Institute

1 BACKGROUND

Wildfire size and severity and the annual area burned have been increasing, to unprecedented levels in recent years, across much of western North America including British Columbia (BC), Canada. During the period 1990 to 2001, wildfires burned 4,000–77,000 ha/y (average = 30,000 ha/y) in BC. Between 2002 and 2016, wildfires in BC frequently burned up to 150,000–370,000 ha/y (average = 148,000 ha/y). A record was set in 2017, when wildfires in BC burned 1.2 million ha. This record was surpassed in 2018, when 2,117 wildfires burned 1.4 million ha. While the total area burned declined to pre-2002 levels in 2019 and 2020, the total area burned in 2021 approached the records set in 2017 and 2018. The duration of the wildfire season in BC has increased in conjunction with the increase in total area burned.

The uncharacteristically large wildfires, so-called megafires, that occurred in BC between 2017 and 2021 showed distinct geographic clusters. Most of these wildfires occurred in upper and middle Fraser River subbasins, which are critical spawning and rearing areas for Pacific salmon and year-round habitat for many other socially and economically important species. In 2018, large wildfires also occurred along the Stikine River (northwestern BC), which is also an important migratory route for Pacific salmon, and in BC's far-north Arctic subbasins.

The recent increases in annual area burned in BC have been attributed, in part, to landscape-management, including fire suppression, practices that have increased standing fuel loads on the landscape and reduced stand heterogeneity[1]. On a larger scale, the recent occurrences of megafires have been associated with warming and drying climate trends which have been attributed to the buildup of anthropogenic greenhouse gases in the atmosphere. Wildfire-climate models predict that the occurrence of megafires will continue to increase, even with wildfire suppression efforts, if climate change forecasts are realized.

[1] see (and references within)

Blanco, J.A. et al. 2015. Fire in the woods or fire in the broiler: implementing rural district heating to reduce wildfire risks in the forest-urban interface. *Process Safety and Environmental Protection* 96:1–13

Brookes, W. et al. 2021. A disrupted historical fire regime in central British Columbia. *Frontiers in Ecology and Evolution* 9: Article 676961, doi: 10.3389/fevo.2021.676961. 14 pp.

Copes-Gerbitz, K. 2022. Transforming fire governance in British Columbia, Canada: an emerging vision for coexisting with fire. *Regional Environmental Change* 22:48. 15 pp.

Halofsky, J.E. et al. 2020. Changing wildfire, changing forests: the effects of climate change on fire regimes and vegetation in the Pacific Northwest, USA. *Fire Ecology* 16:4. 26 pp.

Klenner, W. et al. 2008. Dry forests in the southern interior of British Columbia: historic disturbances and implications for restoration and management. *Forest Ecology and Management* 256:1711–1722.

Ohlson, D.W. et al. 2006. Multi-attribute evaluation of landscape-level fuel management to reduce wildfire risk. *Forest Policy and Economics* 8:824–837.

Stevens-Rumann, C.S. et al. 2016. Prior wildfires influence burn severity of subsequent large fires. *Canadian Journal of Forest Research* 46:1375–1385.

Responses to major wildfires are usually geared towards managing the health and safety of people and to protecting livestock and agricultural lands, industrial, public and domestic infrastructure, and valued timber supplies. In comparison, little attention has been directed towards understanding how major wildfires in BC affect fish and fish habitat and what the response to major wildfires should be from the perspective of protecting, managing and restoring fish habitat. With the increasing wildfire trend across the western North America, there has been a surge in research undertaken to improve our understanding of the impacts of major wildfires. Research has included wildfire impacts on catchment hydrology, terrain stability, erosion and soils/sediment transport and delivery, water and sediment quality (chemical, thermal and physical), fish and fish habitat, and on communities including First Nations peoples who have relied on fish for sustenance and other values for millennia. The literature suggests that many of the effects that major wildfires have on fish and fish habitat are mechanistically linked to the ways in which wildfires modify watershed soils, hydrological patterns and riparian habitats.

The Pacific Salmon Foundation's (PSF) first step in the development of the *Playbook to Guide Landscape Recovery Strategies & Priorities for Salmon Habitat Following Major Wildfires* (the Playbook) was to host a one-day webinar called *Workshop on Salmon Watershed Recovery in Post-Wildfire Environments: From Theory to Practice.* It took place on January 26, 2022. This document provides a summary of the workshop presentations and discussions and highlights key questions raised by the attendees and expert panels.

1.1 WORKSHOP ON SALMON WATERSHED RECOVERY IN POST-WILDFIRE ENVIRONMENTS: FROM THEORY TO PRACTICE

The workshop brought together a multi-disciplinary and multi-sector audience of professionals and interested parties with the broad goal of sharing ideas and working towards the development of a collaborative multiparty framework that can guide real world responses to major wildfires from a fish and fish habitat perspective. The presenters, and many of the attendees, had expertise in fields pertaining to watershed management and restoration, salmon and salmon habitat, climate change and wildfire management. First Nations natural resources teams, provincial, federal and local governments, NGOs (non-government organizations), academia, environmental consulting firms and primary industry were represented at the workshop (Appendix A). More than 200 people attended the workshop, which was hosted virtually on the Zoom Video Communications Inc. platform. A production firm, Oh Boy Productions, managed the technical aspects of the workshop including question-answer management and the recording (sound and video) of the presentations and panel discussions. Oh Boy Productions used audience

interaction software (Slido) to facilitate discussions and to give attendees the opportunity to submit questions and comments to the presenters and hosts in real time.

The primary objectives of the workshop were to:

- convey and transmit knowledge on wildfire impacts to salmon habitat and on mitigation, techniques and watershed recovery strategies;
- provide an overview of the PSF's proposed Playbook;
- provide opportunities for discussion about what the content of the Playbook should include;
- contribute toward the development of a *Wildfire Recovery Community*; and,
- identify individuals, organizations and governments that should be involved in the development of the Playbook.

The workshop was organized into two sessions (9 presentations total):

1. 09:00 to 12:00 hours (morning session)
   Forest Fire Impacts to Watersheds and Salmon Habitat (+ panel discussion)
2. 12:30 to 15:30 hours (afternoon session)
   Management Processes, Actions and Opportunities (+ panel discussion)

The list of presenters, and their affiliations, is provided on the following page. Sections 2 and 3 of this report provide summaries of each presentation, and summaries of the morning and afternoon panel discussions with responses to the representative questions that were submitted via Slido. The PSF has uploaded video files for each presentation and the panel discussion to their YouTube Channel (https://www.youtube.com/user/SalmonFoundation). Links to these video archives are provided in Sections 2 and 3. The information conveyed by the expert presenters and during the panel discussions was incorporated into the Playbook.

Agenda for the Workshop on Salmon Watershed Recovery in Post-Wildfire Environments: From Theory to Practice (January 26, 2002).

Time	Speaker	Discussion Item/Presentation Title
0900–0915 hours	**Jason Hwang** VP Salmon, Pacific Salmon Foundation	**Welcome, aspirations for the session and housekeeping**
0915–0945 hours	**Younes Alila,** Ph.D. University of British Columbia	*Attribution Science: Why the Flood Regime in BC is Super-Sensitive to Disturbances*
0945–1015 hours	**Tim Giles,** M.Sc. P.Geo. Westrek Geotechnical Services Ltd.	*Geomorphic Response to Wildfire in British Columbia*
1015–1045 hours	**Rebecca Flitcroft,** Ph.D. **Gordon Reeves,** Ph.D. United States Department of Agriculture	*Wildfire: A Disturbance That Hits the Aquatic Habitat Reset Button?*
1045–1115 hours	**Nicole Nielson,** MNR Utah Division of Wildlife Resources **Jordan Nielson,** M.Sc. Trout Unlimited	*Miller Time: Cheers to Partnerships and PBR*
1115–1200 hours	**Facilitated Panel Discussion**	
1200–1230 hours	**Lunch Break**	
1230–1300 hours	**Char John** Natural Resources Community Coordinator Secwepemcúl'ecw Restoration and Stewardship Society (SRSS) **Angie Kane** CEO of SRSS **Sarah Dickson-Hoyle,** Ph.D Candidate University of British Columbia	*Indigenous Leadership in Wildfire Recovery and Restoration: Lessons Learned from Elephant Hill and Secwepemcúl'ecw*
1300–1315 hours	**Rachael Pollard,** P.Ag. Association of BC Forest Professionals **Eric Valdal,** M.Sc. BC FLNRORD	*Post Wildfire Landbase Recovery – An Overview of the Elephant Hill Government-to-Government Initiative from the Provincial Government's Perspective*
1315–1335 hours	**John DeGagne,** RPF BC FLNRORD and SERNbc	*Shovel Lake/Island Lake Wildfire Ecosystem Restoration Plans: A Collaborative Approach*
1335–1405 hours	**Doug Lewis,** MNR, RPF BC FLNRORD	*A GIS Indicator-Based Approach for Rapid, Post-Wildfire Watershed Assessments*
1405–1435 hours	**Jeff Morgan,** M.Sc. Consultant to the Pacific Salmon Foundation	*En Route to a Watershed Recovery Playbook*
1435–1520 hours	**Facilitated Panel Discussion**	
1520–1530 hours	**Jason Hwang** VP Salmon, Pacific Salmon Foundation	**Wrap-up and next steps**

2 MORNING SESSION: *FOREST FIRE IMPACTS TO WATERSHEDS AND SALMON HABITAT*

2.1 OPENING REMARKS AND WORKSHOP OVERVIEW

Presenter:	**Jason Hwang** Pacific Salmon Foundation
Title and Video Link:	*Opening Comments*

There was a recognition of the importance of reconciliation with First Nations upon whose traditional territories we live and work and there was an acknowledgement of the impacts that the residential school system has had on communities and individuals. A moment of silence was held in recognition of the recently discovered unmarked graves— with reference to residential schools in both Kamloops and Williams Lake.

2.1.1 OVERVIEW

- Climate change scientists inform us that we will experience large wildfires with increasing frequency and severity.
- Currently in BC there is no Playbook for management actions to mitigate impacts and accelerate the recovery of watersheds following catastrophic wildfires.
- This workshop is intended to bring together scientific and technical experts and the network of engaged First Nations, agencies, stakeholders and NGOs to explore the impacts and risks posed by catastrophic wildfires and to consider our collective response.
- It is also hoped that the presentations and discussions today will help the Pacific Salmon Foundation with the preparation of a *Playbook to Guide Landscape Recovery Strategies & Priorities for Salmon Habitat Following Major Wildfires*.

2.2 WILDFIRE AND FLOOD SENSITIVITY (PRESENTATION #1)

Presenter:	**Younes Alila**, Ph.D. University of British Columbia, Department of Forest Resources Management
Title and Video Link:	*Attribution Science: Why the Flood Regime in BC is Super-Sensitive to Disturbance*
Slide Deck	Appendix Figure 1

2.2.1 KEY MESSAGES

2.2.1.1 Historical Perspective on the Hydrological Impacts of Forest Disturbances

In this presentation, Alila provided a historical perspective of the hydrology literature as it relates to landscape disturbances and floods.

> "*Forest hydrology has a sad history of being embroiled in controversies that never seem to get resolved. Forest hydrologists could be recruited to defend almost any side of a debate, because* [of] *our confusion about the various processes and their interactions in forests and streams*" – Dunne, 1998, p. 795.

In the field of forest hydrology, it has historically been argued that forests and forest disturbances may affect small and medium but not necessarily the larger floods. This belief, while still widely held today, is outdated and largely incorrect.

Old (outdated) understandings in forest hydrology:

- There is no significant relationship between forest disturbances and large floods.
- During large flood events, the influences of forest disturbances are particularly minor in both small and large watersheds.
- The disagreement between the "old understanding" and the "new understanding" is particularly evident regarding questions relating to how forest disturbances affect large flood events in small and large watersheds.

In the past (carrying into present in many cases), have we gotten the physics of forests and hydrology wrong?

The outdated "dogma" that forest disturbances do not significantly influence flood events in small and large watersheds has been based on the non-casual "*Chronological Pairing Framework* (CP)" study design.

- The CP framework just compares the flood magnitude (peak flows) in a disturbed catchment to the flood magnitude in a nearby reference (undisturbed) catchment (i.e., paired-catchments design) in response to, for example, the same precipitation and same snowmelt events (chronological comparisons).
- The CP framework uses regression models for flood prediction.
    - Flood Magnitude (harvested catchment, y-axis) versus Flood Magnitude (forested reference catchment, x-axis) across small, medium and large watersheds.
    - The models, as historically used, do not account for potential changes to flood frequency when comparing harvested catchment versus reference catchment hydrology and flooding.

Alila argues that the non-casual simplistic CP framework study design has hindered the science of forest hydrology and our understanding of how forest disturbances affect floods. New scientific methods, including methods of data analysis/interpretation, have shown that forests and forest disturbance do, in fact, mechanistically affect flood regimes.

- Alila recommends that the forest hydrology community abandon the old CP framework and to adopt the more rigorous, accurate, and defensible "*Frequency Pairing Framework* (FP)" study design when examining the effects forest disturbances on catchment hydrology and flooding.
    - The FP framework compares the magnitude of pre-disturbance and post-disturbance floods when both are of the same frequency (rather than the same chronology).
- Alila suggests that the results of older studies, which use the CP framework, should be re-evaluated using the FP framework.
- When Alila examined the effects of forest disturbances on catchment hydrology and flooding using the CP framework versus the FP framework the conclusions were diametrically opposite.
    - The FP framework method showed that forest harvesting increased low, medium and high peak flows (and also the magnitude of large floods) in small and large watersheds; the CP framework method did not come to this conclusion.

2.2.1.2 What is Wrong with the *Chronological Pairing Framework* Study Design?

- The CP framework study design does not factor in changes in flood frequency.
- The CP framework does not accurately evaluate the effects of forest disturbances on flood magnitude.
- By only comparing flows concurrently in disturbed catchments versus reference catchments, the CP framework does not account for the factors differing amongst the comparison catchments that result in differences in runoff frequency/timing: e.g., differences in precipitations throughfall, snowpack and runoff timing due to microclimate variability, energy causing snowmelt, topography, and rain on snow events.
- The CP framework is not a controlled study design. Cause-and-effect cannot be attributed with the CP framework (CP is not multivariate and it does not factor in random variables).
- The FP framework uses frequency distributions for comparisons (permits cause-and-effect type conclusions) the hydrology and flooding in disturbed catchments versus reference catchments; this is more rigorous and more accurate (in view of predictions) than simple univariate regression-based models (cannot infer cause-and-effect).
- The FP framework assesses the impact of forest disturbances along axes of frequency and magnitude simultaneously. It is a probabilistic method of analysis.

2.2.1.3 Idiosyncrasy of Hydrological Responses to Forest Disturbances

- The impact of forest disturbances can increase with increasing downstream distance within a catchment. That is, the impacts of watershed disturbances are less for the upstream/headwater tributaries. This is not what the CP framework would conclude.
- Forest disturbances can increase flow extremes across all flood-return periods [10-, 20-, 50- and 100-yr and beyond] and increase the frequency of these events.

2.2.1.4 Conclusions

- Forest harvesting significantly affects flood events and the frequency of flood events.
- Forest harvesting affects flooding extremes.
- In mid-to-high elevation zones within mountainous watersheds, flood regimes can be sensitive to even small forest disturbances.
- Watersheds with flat topographies are sensitive to forest disturbances due to the synchronization of snowmelt.

- Small forest disturbances or cut rate can wrongly lead to a prediction that there will be a small impact on flood magnitude and frequency. The effects of forest disturbance on catchment hydrology are also influenced by what is left behind after the disturbance.
- Clear-cutting has the most significant effect on runoff magnitude and flood frequency.
- Full hydrologic recovery after major forest disturbances can take over 80 y.

2.3 GEOMORPHIC RESPONSES TO WILDFIRE (PRESENTATION #2)

Presenter	**Tim Giles**, M.Sc., P.Geo. Westrek Geotechnical Services Ltd.
Title and Video Link	*Geomorphic Response to Wildfire in British Columbia*
Slide Deck	Appendix Figure 2

2.3.1 KEY MESSAGES

2.3.1.1 Wildfire Trends and Responses in British Columbia (an Overview)

- Reviewed BC's history of major wildfires for the period 1998 to2021.
- We live in a wildfire-dominated ecosystem and wildfire can be the dominant driver of change in many interior BC watersheds.
- The BAER (Burned Area Emergency Response) process developed in the United States influenced BC's response to major wildfires.
- BC has largely focused on the geomorphic, hydrologic and soils impacts of wildfires as they affect lives, property and infrastructure.
- The trend over the past 25 years is that wildfires are getting bigger, more destructive and more frequent across much of BC.
- Wildfires used to be most problematic in southern BC, but major wildfires are now frequently seen across the province year after year (especially in the last 10 y).
- Starting in 2017, we are seeing extremely (unprecedented) large fires.
- Wildfire guards have been widely used (successfully) to limit the expansion of wildfires (e.g., McAllister 2014 Fire).
- Our ability to fight fires has become so good that forests have accumulated high masses of fuel, that when ignited can trigger extreme fires.
- Some fires today are so intense that they literally cannot be extinguished.
- Fires often burn "patchworks" into forests (mosaics of burned and unburned areas).

- Sometimes canopy just burns, but sometimes the soils (can leave black ground) and the canopy burns (these characteristics are assessed using burn severity maps, *below*).

2.3.1.2 Burn Severity Mapping

- Typically, one of the first things done after a major wildfire is a burn severity map (e.g., White Rock Lake Fire).
- Can be challenging to make quality burn severity maps, which are made from satellite imagery, because the ground is difficult to see due to unclear atmosphere (wildfire haze and smoke). The haze and smoke can be due to the wildfire under investigation but also the haze and smoke being transported to the area from other wildfires.
- Based on pre-wildfire versus post-wildfire satellite imagery and focuses on impacts to vegetation cover—these are called vegetation burn severity maps until the soil burn severity component is added after field verification.
- Key is to compare images, which are ideally one year apart for vegetation and atmospheric consistency.
- Field testing is done after the initial burn severity mapping is completed. Field testing is to assess factors such as:
    - LFH (duff and litter layers of forest soils) removal.
    - Thickness of remaining soil.
    - Depth to live roots (relates to recovery).
    - Presence of water repellent layer (soil sealing).
    - Presence of coarse fragments (can help assess post-wildfire soils transport) and ash.
    - Vegetation regrowth.
    - Degree that the wildfire has consumed downed woody debris and needles.
- When there is a very high burn severity, the organics component of soils is often completely burned off with just ash remaining.
- The final product is a Burn Severity Map which is field-verified map of soil burn severity and vegetation burn severity.

2.3.1.3 Effects of Wildfires on Watersheds

- Organic LFH is readily burned by wildfires. When burned:
    - Alters soil structure.
    - Reduces organic matter content (OM protects soils and reduces erosion potential).

    - Increases erodibility.
    - When OM vaporizes, water repellency (soil sealing) increases; there is a waxy layer left near the soil surface that repels water.
- Grasslands burn fast and leave blackened soil behind, but they typically do not burn deep into soils.
- The effects of burned soil include:
    - The mineral component of soils is exposed.
    - Loss of structure cohesion.
    - Reduced water infiltration.
    - Increased soil erodibility (not bound up by OM) and water repellency.
- Even small rainfalls can cause erosion post-wildfire.
- Hydrologic effects of wildfires can be significant:
    - Increased and flashier (rapid reaction even to small amounts of precipitation) overland flow including sheet flow.
    - Increased runoff rates.
    - Increased runoff energy increases the rate of soil/sediment transport (often seen as "rills").
    - Need to assess connectivity between burned areas and stream channels.
    - Sediment-laden runoff can be delivered to streams and lakes.
    - Boulders can be moved on even gradual slopes.
    - Wildfires can increase the risk of freshet (snowmelt) floods and flow peaks during rain events.
    - Rain on snow events during warm springs can increase flood risks post-wildfire.
- Hydrogeomorphic risks of wildfires can be significant:
    - Floods, sediment-laden floods, debris flows and floods caused by debris blockages, landslides and rock falls.
    - We see terrestrial debris flows across much of burned BC.

2.3.1.4 Post-Wildfire Watershed Assessments

- Tools for post-wildfire assessments include:
    - Topographic, surficial geology and bedrock geology maps.
    - Lidar (using more often now), looking for alluvial fans.
- Examine physiographic characteristics that are related to the potential for wildfire impacts to watersheds (risk factors):

  - Longitudinal profiles (is area steep enough to result in post-wildfire soil movements and debris flow?).
  - Melton ratio.
  - Relief index.
  - What is located at the bottom of burned slopes? (roads, homes, streams etc.). We often build where we should not build. Need to assess the elements at risk.
- Post-wildfire natural hazards risk analysis:
  - Undertaken to quantify the downslope and downstream risks to life, property and infrastructure ("elements at risk").
  - Reconnaissance assessment:
    - Identifies the elements at risk.
    - Characterizes the observed natural hazards.
    - Estimates the partial risk to the identified elements at risk.
  - If warranted, follow up with a detailed assessment:
    - Requires consideration of burn severity and wildfire impacts to soils, hydrology and terrain stability.
    - More detailed hazards and risks assessment of factors identified during reconnaissance assessment.
    - Identifies the need for risk mitigation/restoration.
    - Provides conceptual designs for the mitigation/restoration measures.

2.3.1.5 Post-Wildfire Weather and Climate Risks

Some guidance (information) related to wildfire risks is found in Snow Basin Index and River Forecast Centre.

2.3.1.6 Post-Wildfire Watershed Recovery

- Post-wildfire recovery can be slow.
- Water repellency is common for 1 to 3 years post-wildfire.
- Soil regeneration: it takes time to accumulate and decay grasses, mosses and shrubs. Thus, the LFH layer can remain thin for years.
- Rocky ground is slow to recover. The most significant factor relating to recovery is soil regeneration.
- Factors affecting recovery include aspect, biogeoclimatic zone and salvage harvesting.

2.4 WILDFIRE AS AN AQUATIC HABITAT RESET (PRESENTATION #3)

Presenters	**Rebecca Flitcroft**, Ph.D. and **Gordon Reeves**, Ph.D. Pacific Northwest Research Station, USDA Forest Service
Title and Video Link	*Wildfire: A Disturbance That Hits the Aquatic Habitat Reset Button*
Slide Deck	Appendix Figure 3

2.4.1 KEY MESSAGES

2.4.1.1 Wildfire Processes: Effects of Wildfires on Aquatic Ecosystems

- Are wildfires catastrophic to aquatic ecosystems? Or, do wildfires reset aquatic habitat?
- Wildfires are one of the most significant natural disturbances in terrestrial environments.
- Wildfire shapes the community structure, including species diversity, of both terrestrial and aquatic ecosystems.
- Wildfire trends: wildfires have always occurred, but they are becoming more extreme.
- Since the 1980s, wildfires trends in the US include:
    - Increased wildfire frequency.
    - Wildfires are getting larger.
    - Wildfire seasons are becoming longer.
- Recent wildfire trends have had severe impacts on people and their communities.
- Recent wildfire trends are related to the combined effects of our current land-management practices (build up of fuels in forests) and climate change.

How did we get into the current wildfire regime?

- Our wildfire suppression actions permit fuel build up in forests. Absence of wildfire has allowed more fire sensitive species to take over.
- Removal of the largest trees when logging. These were the most fire-resistant trees (thickest bark).
- There are now more trees growing on the landscape than there was historically.
- Our land management has reduced the mosaic (patchwork) structure (and diversity) of terrestrial ecosystems that had natural wildfire breaks (space between forest patches).
- Climate change.

2.4.1.2 Landscape Mosaic (Patchwork) Concept

- Natural mosaics (prior to current forest management and wildfire policies) formed natural wildfire breaks and created habitat diversity within the landscape.
- Historically, landscape mosaics were reflected in aquatic habitats.
- With mosaics, there were large gaps in forests (natural wildfire breaks).
- We now see uniform forests with less fire-tolerant species. We have lost the mosaic landscape structure.
- Habitat complexity has declined. Wildfire severity risk has, in turn, increased significantly.
- Indigenous practices: we have lots to learn from them.
    - Indigenous peoples intentionally set fires in the past do reduce wildfire severity, to promote the growth of food plants and to enhance forage for ungulates.

2.4.1.3 Current Wildfire Policy Perspectives

- View fires as being bad/catastrophic to fish. Premise is that fish die after wildfires because wildfires destroy ground cover, and the streams and rivers fill with silt and other terrestrial debris.
- Clean streams with clear water are best for fish.

2.4.1.4 Alternate Perspective on Wildfire and Fish and Fish Habitat

- In the short term after wildfires, waters become more turbid however the materials delivered to streams during wildfires, in the long term, can contribute the building blocks for habitat complexity and aquatic ecosystems.
- The initial negative impacts of wildfires are often temporary. The important thing is what the effects of wildfires are in the long term.
- With low intensity fires, riparian areas can act as natural wildfire breaks. The issue now is that wildfires have become more intense due to the combined effects of our land-management practices and climate change.
- Riparian areas can recover more quickly from wildfires that upland areas.
- Fishes and other organisms have evolved in disturbance regimes, including wildfire disturbances.
- Uncharacteristic wildfires might not be negative in view of aquatic ecosystems and fish in the long run.

- Wildfires might lead to the long-term persistence of fish populations by periodically resetting habitat.
- Evidence indicates that fish that have evolved with wildfire disturbance have adaptations that enable them to thrive in the years following wildfires. There is usually an immediate impact to fish, but the populations recover and take advantage of the habitat reset.
- There are limits to the possible long-term benefits of wildfires on aquatic ecosystems including fish. The limits occur when fish populations are restricted to small areas or are isolated from other populations (wildfires can affect hydrologic connectivity).

2.4.1.5 Wildfire Management from a Fish Habitat Perspective

The evidence shows that aquatic systems can become quite productive following the initial impacts of wildfires.

- Immediately following wildfires, many materials (e.g., sediment, wood, nutrients) are delivered to streams (this promotes productivity).
- Suspended sediment concentrations will decrease over time, woody debris will increase in channels, primary production increases, and we see a flourishing of the invertebrate assemblages and, in turn, benefits to fish. This is a generalization to make a point.
- Fish growth rates can increase after wildfires (length at age increases) as seen for rainbow trout; this is most significant at the most disturbed areas. The disturbance is a habitat reset and fish are adapted to take advantage of this.
- Rainbow trout become mature earlier after wildfires (it is an adaptation for recovery).
- There might be decline in one species post-wildfire (e.g., steelhead) but an increase in the better adapted resident species/sub-species (e.g., rainbow trout). These species can alter their life history form/behaviour depending on environmental conditions.
- The different life histories (steelhead versus rainbow trout) might actually be an adaptation to disturbance events.
- The relative abundances of species can change post-wildfire.
- Wildfire disturbances can help native, fire-adapted species to recover. For example, invasive brook trout can substantially decline after wildfires, but this is to the benefit of adapted native species (bull trout and cutthroat). Native bull trout and cutthroat rebounded after wildfire while the invasive species (brook trout) declines.

How are native species adapted to wildfire disturbances?

- Genetic flexibility (steelhead and rainbow trout example).

- Movement/straying of adults after wildfire (need to make sure wildfires did not impact hydrologic connectiveness which could limit movements). Fish can temporarily avoid the limiting impacts of wildfires until habitat recovers.
- High fecundity (high reproduction).
    - Mobility of juveniles (hydrologic connectivity is important for recovery). It used to be believed that the less fit individuals stray; but mobility it is an adaptation to disturbance.
- Post-wildfire alluvial fans can create complexed habitats (wood, solids etc.) for aquatic species. Increase community diversity. Alluvial fans can, for example, be quickly colonized by bull trout.

Considerations for Responses to Wildfires:

- As indicated, fish populations can be severely impaired by wildfires if they are trapped in small areas and not able to use their adaptation to move out temporarily until the immediate impacts of wildfires recover.
- A first response to wildfires from a fish and fish habitat perspective would be to assess whether the wildfire has caused stream blockages (impacted hydrologic connectivity) or introduced toxic substances.
    - Has the wildfire clogged culverts with debris? (blocking movements).
    - Has the wildfire dammed bridge pylons with debris? (blocking movements).
    - Has the wildfire caused landslides that can dam streams? (blocking movements).
    - Have polluted soils and fluids entered streams due to the wildfire? (toxicity).
- Look at landscape to assess specific risks (e.g., impacted in connectivity) to fish and fish habitat. Target these areas in any mitigation plan.
- Wildfire prevention is better than reactive responses.

2.4.1.6 Are Wildfires a Threat to Fish?

- Other human impacts to fish and fish habitat are probably more of a threat than wildfire.
- The impacts of climate change might override other cumulative effects in the long term.
- If we let the effects of wildfires playout with the understanding that aquatic ecosystems are adapted to wildfire disturbances, wildfires in the long term might be beneficial to aquatic ecosystems including fish communities.

- Other than around infrastructure (e.g., roads, road crossings, logged areas etc.) we might not need to respond to wildfires from a fish and fish habitat perspective.
- Salvage logging might reduce the benefits of wood delivery to channels.
- Could fire be used as a restoration tool?

2.5 COLLABORATIVE PROCESS-BASED RESTORATION OF AQUATIC HABITATS (PRESENTATION #4)

Presenters	**Nicole Nielson**, MNR Utah Division of Wildlife Resources **Jordan Nielson**, M.Sc. Trout Unlimited
Title and Video Link	*Miller Time: Cheers to Partnerships and PBR*
Slide Deck	Appendix Figure 4

2.5.1 KEY MESSAGES

2.5.1.1 The Miller Creek Restoration Partnership

- Restoration partnership developed after a major wildfire in 2012.
- Post-wildfire damage was caused by post-wildfire flooding events.
- Partnerships were between:
    - BAER/ESR (emergency response & rehabilitation) teams.
    - Utah's WRI (Watershed Restoration Initiative)-Fire Rehabilitation which has a dedicated fund for post-wildfire restoration. The WRI is funded by the State of Utah, the US federal government, and conservation groups. Several million dollars per year in funding across Utah.
    - NGOs (a huge role in the Miller Creek restoration projects).
    - Agency resource specialists for guidance.
    - Industry (e.g., oil and gas).
    - Landowners (much of the restoration was done on private lands and people were keen).
- Utah's state government worked closely and collaboratively with the team.
- The Utah Legislature has prioritized wildfire management and post-wildfire restoration (legislation is a tool that can be used to assist with restoration).

- A key aspect in the successful formation and function of the partnership was to clearly define roles and objectives and establish common ground within a partnership composed of individuals with different backgrounds, perspectives, responsibilities and outcome expectations.

2.5.1.2 2012 Upland Restoration Efforts

- Prioritized high severity burn areas having slopes 30% or less.
- Seeded burned area with annuals (sterile varieties) during fall 2012.
- Mulching of area trees (soil rehabilitation).
- Noted that straw bale mulching has been used in other fires for soil rehabilitation.
- The BAER teams had exceptional knowledge and expertise (very helpful).

2.5.1.3 2016 Stream Restoration Efforts

- Observed impacts of the wildfire were:
    - Increased peak flows.
    - Areas of deeply incised channel.
    - Above impacts were also caused by other factors (cumulative effects, or "death by a thousand cuts").
- Tested PBR (process-based restoration) techniques that employed low-tech structures including BDAs (beaver dam analogs). Used branches from local tree species to weave into the BDAs.
- Experienced quick successes and the partnership grew.
- Purpose of BDAs was to aggrade the channel and to capture sediment. Also, to enhance habitat complexity.
- Some BDAs blew out during high-flow events, but they still captured sediment and aggraded the channel. The intention for them is to be temporary (they are built to fail).

2.5.1.4 2017 Planning

- Continued with partnership building.
- Submitted proposals and secured funding for restoration projects.
- Up until 2017, the partnership just took on one-off projects (no stable funding).
- In 2017, the partnership secured stable, multi-year funding. This enabled long-term strategic planning and on-the-ground projects to be undertaken.

- The funding enabled pre-treatment monitoring to establish baseline conditions (Rapid Riparian and Stream Assessment method) so that restoration works could be evaluated.

2.5.1.5 2018 Restoration Projects

- With the stable long-term funding secured in 2017, the partnership went to work in 2018 with more longer-term objectives in mind.
- Three types of post-wildfire restoration activities were planned:
    - Installation of large durable structures (e.g., a step-down log structure).
    - Installation of PBR low-tech structures such as BDAs.
    - Strategic tree felling into the channel (employed a contract logging crew) where it was deeply incised. Partnered conservation core crews with the tree fellers and other contractors for guidance.
- Restoration works were undertaken in an upstream to downstream direction.
- Made an agreement with landowners to keep cattle out of areas where restorations works had been undertaken.
- Installed structures in the fall and planted the following spring.

2.5.1.6 2019 Restoration Projects

- Recruited more volunteers to help with planting and constructing BDAs (community building and education).
- More landowner outreach (partnership building).
- Work in 2019 focused on lower reaches of Miller Creek and on planting.

2.5.1.7 2020 Restoration Projects

- Continued to install BDAs.
- Learned about post-assisted log structures and installed several of these. These worked particularly well in areas with hard substrates.
- Key was that the partnership learned from year to year about what approaches worked and which ones did not.

2.5.1.8 2021 Restoration Projects

- The partnership did not have much in the way of baseline fish inventory data.

- The partnership transplanted fish (speckled dace) to Miller Creek in 2021. Plan is to transplant Colorado cutthroat trout to Miller Creek in the future.

2.5.1.9 Post-Wildfire Restoration Outcomes

- Seeding was done during fall 2012 with the intention that it would germinate the following spring after snowmelt.
    - It was observed that while the seeds germinated, the roots often did not penetrate the soils. Therefore, the seeding did not work out completely as planned. It might be necessary to scarify burned soils before seeding.
    - Some seeding was successful, and the seeding helped decrease the invasive cheatgrass population.
- While many BDAs did eventually blow out, they spread out the water as hoped, capturing sediment, aggrading the channel and increasing natural channel sinuosity.
- Downstream landowners saw firsthand the benefits of the upstream work in view of channel aggradation and sediment capture and flushing out into the floodplain.
- Saw some natural vegetation establishment over the structures.
- Became a flagship project for Utah's WRI.
- Early results lead to increased outreach work to recruit more partners and for educational purposes.
- The restoration improved water quality, fish habitat, terrestrial wildlife, and channel structure (as determined by Rapid Riparian and Stream Assessment).

2.6 MORNING FACILITATED DISCUSSION

Panel members	**Younes Alila** University of British Columbia, Department of Forest Resources Management **Tim Giles** Westrek Geotechnical Services Ltd. **Rebecca Flitcroft** Pacific Northwest Research Station, USDA Forest Service **Gordon Reeves** Pacific Northwest Research Station, USDA Forest Service **Nicole Nielson** Utah Division of Wildlife Resources **Jordan Nielson** Trout Unlimited
Video Link	*Morning Panel Discussion: Workshop on Salmon Watershed Recovery in Post-Wildfire Environments*

2.6.1 EXPERT PANEL REMARKS AND RESPONSES TO SLIDO QUESTIONS

To recap the morning session, Jason Hwang invited participants to share their thoughts and to comment on what they heard.

Tim: In BC, our geology is glacial sediments – ubiquitous cover – and we see different things in the US. We have a very young landscape as well. Interested in some of the things happening in California last fall. Different styles of failure. So many similarities in what we are seeing. Liked hearing from Gordon and Rebecca on the positive effects of fire. The negative now is that we are having bigger fires and we need to go back to smaller fires.

Rebecca: Agree with Tim there are parallels in our landscapes. Keeping the broader perspective that there are some positive outcomes. The very large fires are problematic and may be something we can address through management, but wildfires are not going away. It will be our future. Need to learn to manage and live with wildfire. Gordon talked about adaptations that our native species have to wildfire. Important to maintain connectivity in aquatic environments, post-fire and pre-fire. Understanding barriers to movement is key to aquatic systems.

Gordon: We have our terrestrial counterparts—in the northwest there is emphasis on diverse early habitat. Fires are one way of establishing these early areas. Sometimes there is a conflict between interests of aquatic and terrestrial systems. Early successional stage following fires tends to be the most diverse and productive portion of the cycle. We are trying to push streams back to something we think they should be, and our terrestrial counterparts are looking at it differently. Rebecca talked about the landscape in Oregon, there are two to three times more trees now than 100 years ago. What did the landscape really look like? Trying modelling to show what it looked like regarding the effects of fire. By our best guess, we think about 60% of the watersheds were in what we would consider good condition (standards of today), that there was a mosaic of conditions moving across the landscape and everything wasn't good. We can't just do it on one area, we have to look at the entire landscape for health as opposed to single spots.

Probing a bit further on the perspective that fires are natural disturbances and are not necessarily negative from a fish and fish habitat perspective.

- **In light of the effects of human activity, both up until now and the results of climate change, does that alter the thinking around considering interventions if there are things we are trying to manage for (i.e., salmon population at conversation risk)?**
- **Or, do you still stick with the baseline that these are natural systems, fire is part of the natural system, and we shouldn't focus too much on mitigating effects?**

Rebecca: We need to look at the characteristics of wildfires. What we are seeing today is an intersection of current management and climate changes. Look at controlled burns to control intensity of burns that exceed what we might expect for specific areas. In some instances, allowing fires to burn may be the right thing to do. The post-fire effect could be beneficial when we do allow things to burn. Making sure there is connectivity in the system, culverts, etc. If you have populations of fish that may be vulnerable to wildfire and damage to the landscape, you may want to reduce the fire intensity as much as possible and do restoration for those populations. We saw that in some modelling work in the Wenatchee system. Understand vulnerabilities of fishes and trying to work proactively to support populations that are threatened.

Gordon: We need to recognize we are not going to stop wildfires. The landscape is set up to burn, and we may be changing the effect of fires. Can we have pre-fire burns to reduce fuel loads? Can we begin to identify places we don't want to see burn because we know that it will have a major effect? We need to be proactive with fuel reduction or create fuel

breaks to reduce the loss of particular segments. These could be done pre-fire strategically. It is not just doing something; it is where we do it in the landscape.

SLIDO QUESTION: What does Younes' presentation have to do with fire and post-fire treatments for fish? No one disagrees that reductions in forest cover have positive effects on flood frequency and magnitude - how does this relate to the topic at hand?

Younes: There aren't so many pristine watersheds in BC that would have been impacted only by wildfire. Typically, watersheds affected by wildfires are also affected by other disturbances such as historic harvesting, forest roads, and climate change. Therefore, fish in the channels are not being subject to the effects of wildfire in isolation but to the cumulative effects in space and over time of all the disturbances in the watershed!? I'm not aware of any study that have used the probabilistic framework to evaluate the effect of wildfire in a watershed affected by multiple disturbances, including wildfire. In addition, we should be interested not only in the immediate short-term effect of wildfire on fish but also in how the fish reacts to the repeated threats from the increase in frequency of the peak flows over the longer term. Literature looks at one event at a time (chronological pairing) and that framework is noncausal. It leads to the incorrect effects of wildfire on the magnitude of peak flows and is not designed to reveal how the wildfire may be increasing the frequency of such peak flows over time.

Nicole: In Miller Creek, we saw more impact due to other disturbances. In some fire areas there was a healthy riparian area and it held up better to large blows than a degraded system.

Tim: The scale of the problem in BC is that we have such big fires. The bigger watersheds react more. We haven't been thinking on the big scale. Do we protect the best first? The headwaters? Downstream?

Jordan: There are huge differences from Utah and PNW (Pacific Northwest) and BC. When we have a catastrophic, uncharacteristic wildfire it wipes out our fish population. I don't know if you have that same issue with fisheries there? It is probably beneficial to identify your meta populations of salmon and protect those first. My guess is that the landscape is a bit more resilient to fires with your levels of precipitations.

Jason: Some conservation management planning here in BC salmon is probably ahead of others.

SLIDO QUESTION: Are wildfires similar or different to harvesting with respect to hydrological impacts and peak flows?

Younes: The effect of wildfire on the magnitude and frequency of floods could actually be worse, especially over the shorter term. Although the effects of wildfire on floods induced by soil hydrophobicity might be thought of as only temporary, the loss of tree cover to wildfire, or by subsequent salvage logging, may cause longer term effects especially in the form of an increase in the frequency of floods, mimicking the effects of conventional harvesting. Viewed from this window, the effects of wildfire can be way bigger than the effects of conventional harvesting.

Tim: The fire is worse than harvesting for scale. Harvesting is relatively confined. Can break out the hydrophobic soils but replanting some areas and not others. Fire across the riparian zone is terrible as we don't generally harvest in riparian zones.

Gordon: We need to view fire as a disturbance (so is timber harvest) and we need to think of the frequency and legacy of the disturbance. What is left over that the system can use to move in a different direction or recover itself? In salvage logging, we have potentially compromised a key legacy to the aquatic ecosystem. One you've deprived the stream system of the component, but we are also worried about erosion and debris flow following timber harvest and wildfire. Interesting work in Oregon that when you have large wood in the debris flows they behave differently. Once they are there, the system has large wood and sediment. Need to think in terms of processes and how we alter the occurrence and the legacy of the process? It is not just what we do, it is where we do it.

SLIDO QUESTION (FOLLOW UP): Does it matter if we are talking about green tree harvesting or burned-tree salvaging? Or is it a matter of you are changing the forest cover in either situation?

Tim: The recommendations after the Elephant Hill Fire had directives for hydrologic recovery, geomorphology and other aspects. In salvage harvesting it is recommended not to harvest over 30% slope unless careful working on steeper ground. This is usually done by skidder and causes more ground disturbance. Always harvest the black, not the red or the green.

Jason: **Is the guidance for salvage particularly different than that for green tree harvest? For example, there has been a fire and what do you do? Or, if you are looking at what is good or least bad for salmon what would you do?**

Tim: Logging companies find it too costly to do cable logging on the steeper slopes. It changes how the logging companies look at the salvage opportunity and they go for gentle slopes. They go for mixed black, green and red. We push them towards black, avoiding riparian, snow zones, core planting sites and rocky sites. The guidance is in place, and we understand it, but getting that on a block-by-block scale is difficult.

SLIDO QUESTION: Gordon's perspective on fish recovery post-fire and post-disturbance is very positive. Are there planning considerations here? That is, are there management or restoration activities that should or should not be done post fire?

Gordon: Planning, yes. The idea of legacy and the legacy of the ecological process and legacy of the fire, making sure we retain those. That will determine how the system will respond. If it has the components that we know are needed for restoration or recovery in it, then it can move forward. We should identify where those processes occur on the landscape either during the fire or post fire use that to determine what to do. Need to think of landscape now in terms of connectivity. That is something we need to prioritize and work on right now. It is not something we want to think of post fire as that may be too late.

SLIDO QUESTION: I work on salmon/steelhead in the Chilcotin watershed, interior BC. We've had recent large wildfires, salvage logging, pine beetle impacts. What framework can help guide "proper" restoration/silviculture to prevent repeating mistakes?

Gordon: Doing the right thing in the right place is key. Knowing on the landscape where those places are and prioritizing them at the right places where we want to have big trees. We may be in the early portions of our understanding, but we are gaining. There are tools available to guide the activities and to help ensure that we are going to get the biggest bang for our buck.

Jason: Are there tools you could point us to in BC that have been used successfully elsewhere?

Gordon: Platform LAT (Landscape Analysis Tool). Series of landscape analysis tools. We need to recognize that we need to be strategic to be effective.

Rebecca: As we are trying to understand and prioritize aquatic habitats and processes in systems, we need to have aquatic folks and terrestrial folks at the table at the same time to develop and understanding the broader spatial extent between landscape and aquatic systems. This will make sure that the framework is integrating different perspectives.

SLIDO QUESTION: We need to examine harvesting practices in relationships to the existing riparian health at time of the wildfires. We are creating wicks that are carrying fire from slash block to slash block, especially where Mountain Pine Beetle salvage was taking place.

Gordon: A key part is management of riparian areas. Oregon saw reluctance to manage riparian areas. There is fear of the negative effect on aquatic habitat. We need to think about what does it mean to manage these areas? Being able to manage from the edge of the stream to the outer edge of riparian areas. We need to have significant conversations about what riparian management means and looking at options other than no management. No, management does not mean no effect.

SLIDO QUESTION: There seems to be a lot of interest in beavers for restoration. For example, the use of BDAs. Perhaps they help create fire-resistant riparian areas, and also create fish habitat. Please provide perspective.

Jordan: Our partner from the fish and wildlife programs described that BDAs spread the water across the landscape and create a green ribbon. In a desert state, the green ribbons are very pronounced and help with fire resilience. With habitat, it depends where we put them. Usually, we have degradation of the stream bed and it down cuts, trying to get the stream bed back up to the flood plain. This does not always create a lot of fish habitat. But, if we are putting them in as a precursor to fire to prevent damage then it certainly does. It creates a deep pool cover that fish like a lot.

3 AFTERNOON SESSION: *MANAGEMENT PROCESSES, ACTIONS AND OPPORTUNITIES*

3.1 INDIGENOUS LEADERSHIP IN WILDFIRE RECOVERY—ELEPHANT HILL WILDFIRE RESPONSE (PRESENTATION #5)

Presenters	**Char John** Natural Resources Community Coordinator for Secwepemcúl'ecw Restoration and Stewardship Society **Angie Kane** CEO of Secwepemcúl'ecw Restoration and Stewardship Society **Sarah Dickson-Hoyle**, Ph.D. Candidate University of British Columbia, Faculty of Forestry
Title and Video Link	*Indigenous Leadership in Wildfire Recovery and Restoration*
Slide Deck	Appendix Figure 5

3.1.1 KEY MESSAGES

3.1.1.1 Secwepemcúl'ecw Restoration and Stewardship Society

The Secwepemcúl'ecw Restoration and Stewardship Society (SRSS) was founded by eight Secwépemc communities following the 2017 Elephant Hill Wildfire. It was formed to advance sustainable management of *tmicw* (land) and resources.

3.1.1.2 Key Projects

- Key projects undertaken by the SRSS include:
  - The Elephant Hill Fire riparian restoration project (BC SRIF funded—focus on salmon habitat).
- Natural capital evaluation.
- Cultural heritage resources—monitoring program.
- Carbon monitoring.
- Implementing Elephant Hill Fire "lessons learned".

3.1.1.3 Project Overview and Lessons Learned

- A joint project with SSRS and UBC's Faculty of Forestry.
- The project included in-depth interviews and documentation of joint wildfire recovery initiatives.
- The final report documents the Secwépemc and provincial experiences regarding the 2017 Elephant Hill Fire. It documents:
    - The causes of the wildfire.
    - Government-to-government processes for recovery from the wildfire.
    - What the responses to the wildfire were and outcomes.
    - Lessons learned.
    - Barriers to true partnerships in wildfire management.
    - Key findings and calls to action.
- Indigenous perspectives are important when considering and implementing responses to major wildfires: "*We're tied to the land. When you walk across the land, you feel the people who were there before you.*" There is a need to recognize the impacts of major wildfires on Indigenous ways of life.
- There are risks to fast-tracking pre-determined recovery activities.
- It is critical to access Indigenous knowledge when creating this Wildfire Playbook and associated models.
- There are conflicting perspectives on recovery — short-term versus long-term ecosystem restoration.
- We need to invest in long-term relationship and capacity building and G2G (government-to-government) partnerships.
- There are concerns that documentation for the Elephant Hill Fire has not been shared with others (government/public) and regarding the lack of meaningful joint decision making/recovery following recent wildfires.
- There is a need to review the lessons to make sure that they are truly lessons learned.

3.1.1.4 Recommendations

- Establish a provincial wildfire recovery framework that:
    - Identifies roles, mandates, and commitments with First Nations.
    - Identifies key partnerships/resources, timelines, and decision-making processes.

  - Proposes a framework for collaboration across Forest Lands, Natural Resource Operations and Rural Development (BC FLNRORD) regions and districts.
- Co-develop, fund and implement strategic wildfire recovery initiatives.
- Protect and revitalize archaeological and cultural heritage locations that have been affected by wildfires.
- It is important for the Wildfire Playbook to include the point that responses should not be planned or implemented without including Indigenous perspectives from the very start: "*Projects that don't involve First Nations from the get-go don't work.*"
- The first step in wildfire recovery must be joint planning and relationship building. We need to be "walking on two legs" and weaving together Indigenous and western science.
- In lots of processes, Indigenous communities do not feel they are being taken seriously enough or that their input is valuable. Indigenous communities are ready for collaboration and to work together.
- "We want control and resources to do it right, *and not just the outcome based but the identity that comes with doing that work, the skills, the way that it helps people to live, and rebuild who we are and our relationship to the land.*" ~Former Kukpi7 Ryan Day, Sťuxwtéws.

3.2 G2G POST-WILDFIRE INITIATIVE—ELEPHANT HILL WILDFIRE RESPONSE AND RECOVERY (PRESENTATION #6)

Presenters	**Rachael Pollard**, P.Ag. BC Ministry of Forests, Lands, Natural Resources Operations and Rural Development **Eric Valdal**, M.Sc. BC Ministry of Forests, Lands, Natural Resources Operations and Rural Development
Title and Video Link	*Post Wildfire Land Base Recovery—An Overview of the Elephant Hill Initiative*
Slide Deck	Appendix Figure 6

3.2.1 KEY MESSAGES

3.2.1.1 Background and Context

- In 2017, the Government of Canada and Government of British Columbia committed to reconciliation with First Nations peoples and to implement UNDRIP (United Nations Declaration on the Rights of Indigenous Peoples).
- In 2017, the Elephant Hill burned 191,000 ha of Secwépemc Traditional Territory (Cariboo and Thompson-Okanagan regions).
- The landscape in the burn area was already widely impacted by other disturbances (cumulative effects can complicate responses to wildfires in BC).
- G2G agreements were established for working together on post-wildfire restoration, using a landscape-level approach.

3.2.1.2 Response to the 2017 Elephant Hill Fire (an Overview)

- A cumulative effects watershed assessment was undertaken to identify lands and waters that were affected by disturbance prior to the wildfire:
    - Compromised riparian areas.
    - Roads and sedimentation.
    - Equivalent cleared area
- The approach included:
    - G2G collaboration.
        - Shared decision making supported by Leadership Tables (Secwépemc Kukukpi7 and Provincial Directors).
        - A Collaborative Retention Plan was developed by collaborative Technical Tables and endorsed by Leadership Tables.
    - A "*Health of the Land First*" philosophy guided the response approach.
- The core objectives were:
    - Further government's commitment to reconciliation by working in a government-to-government approach.
    - Rehabilitating wildfire guards.
    - Salvaging of burned stands.
    - Range Recovery.
    - Reforesting burned forests, consistent with the Chief Forester's Guidance (both salvaged and non-salvaged areas).
    - Collaborate with FN.

    - Work to follow the Chief Forester's guidance around harvesting and salvage.
- Chief Forester's Post-Natural Disturbance Forest Retention Guidance can be found here: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/2017_fire_report_revised.pdf

3.2.1.3 Select Elephant Hill Recovery Initiatives

- Strategic retention and salvage.
- Fireguard rehabilitation (very important for fish and fish habitat values).
- Reforestation to recover riparian and upland areas, hydrologically sensitive zones and forest ecosystems.
- Steelhead populations (assisted migration)— boulders caused blockages to connectivity.
- Closures to off-road vehicles.
- Collaborative monitoring of impacts to values and recovery progress.

3.2.1.4 Conclusions

- Joint G2G leadership was and is critically important.
- Salvage/retention planning and silviculture activities focused on multiple values rather than a single value (i.e., timber).
- Recovery from wildfires takes a long time.
- Longer-term restoration initiatives have started and are ongoing.

3.3 COLLABORATIVE RESPONSE TO ECOSYSTEM RESTORATION AFTER THE SHOVEL LAKE AND ISLAND LAKE WILDFIRES (PRESENTATION #7)

Presenter	**John DeGagne**, RPF BC Ministry of Forests, Lands, Natural Resources Operations and Rural Development and Society for Ecosystem Restoration in Northern BC
Title and Video Link	*Shovel Lake/Island Lake Wildfire Ecosystem Restoration Plans: A Collaborative Approach*
Slide Deck	Appendix Figure 7

3.3.1 KEY MESSAGES

3.3.1.1 Landuse Planning and Wildfires

- Landuse planning in the context of wildfires is necessary for the identification of where and what the important values are and what needs to be done.
- Need to link land use planning to tactical activities on the land base.
- Ideally, land use planning in the context of wildfires would be done before major wildfires occur.
- First Nations need to be involved at all stages. We need to go to First Nations first.

3.3.1.2 Shovel Lake/Island Lake Wildfires Emergency Response Plan

- Guiding principles of the Shovel Lake/Island Lake ERP:
    - Collaborate, at all stages, with First Nations communities that have been impacted by the wildfires.
    - Promote ecological integrity and resilience.
    - Coordinate with other programs.
    - ERPs are non-legal plans. They rely on communications and partnerships.
- Guiding values of the Shovel Lake/Island Lake ERP:
    - Timber.
    - Range.
    - Forest biodiversity.
    - Landscape connectivity.
    - Watershed health.
    - Wildlife.
    - Cultural areas.
    - Berries, mushrooms and medicinal plants.
- Priority restoration zones:
    - Wildland-urban interface (where people and infrastructure exist).
    - Wildfire guards.
    - Special restoration zone (broad suite of non-industrial values such as visual quality areas, provincial parks, ecological reserves, old growth management areas, forest ecosystem networks, ungulate winter ranges, Omineca ESI [Environmental Stewardship Initiative] areas).
    - Timber restoration zone.

3.3.1.3 Implementation of the Wildfire Emergency Response Plan

- Salvage logging by zone type. What should be salvaged? What should be left behind?
- Salvage logging guidance, within zone types, is based on burn severity.
- Silviculture of various methods is used to restore soils that have burned.
- Cluster planting immediately after wildfire. Distributed planting to promote berry growth and regeneration.
- ERPs promote natural regeneration/succession when possible.

3.3.1.4 Next Steps

- Building relationships with Regional Districts and licensees.
- Seek cooperation and collaborative partnerships.
- Access funding.
- Monitor, research, learn and adapt.

3.4 GIS TOOL FOR RAPID POST-WILDFIRE WATERSHED ASSESSMENTS (PRESENTATION #8)

Presenter	**Doug Lewis**, MNR, RPF BC Ministry of Forests, Lands, Natural Resources Operations and Rural Development
Title and Video Link	*A GIS Indicator-Based Approach for Rapid, Post-Wildfire Watershed Assessments*
Slide Deck	Appendix Figure 8

3.4.1 KEY MESSAGES

3.4.1.1 GIS Indicator-Based Tool to Inform the Wildfire Playbook

- Tool developed to evaluate effects of a broad range of disturbances on watershed condition.
- Tool can also be used for a rapid post-wildfire watershed assessment.
- Developed with a broad community of forest hydrologists.
- The tool is based on:
    - Watershed Assessment Procedure (WAP 1999).

  - GIS-Based Hydrologic Screening Decision Support Tool (Carver and Utzig 1999).
  - Qualitative Hydromorphic Risk Analysis for British Columbia's Interior Watersheds (Green 2005).
  - Kamloops TSA Watershed Screening Tool (Brown et al. 2007).
- Tool is currently being used in several provincial regions:
  - Thompson-Okanagan.
  - Cariboo.
  - Kootenay-Boundary.
  - Omineca.

3.4.1.2 Tool Overview

- Quantifies relative potential hydrological hazards.
- Suitable for large areas (millions of hectares) and for numerous watersheds.
- Can be used as part of a risk-based approach where downstream elements that are at risk are identified, such as:
  - Domestic water intakes.
  - Private properties.
  - Public infrastructure (e.g., roads and bridges).
  - Fish and fish habitat.
- Can be used to prioritize and proactively direct resources to high-risk catchments (risk management).
- The tool uses a risk-based approach. For assessment units (AU), it uses hazards and consequences to categorize risk as low, moderate or high.
  - Hazard categories, include GIS indicators of key hydrologic processes related to:
    - Extreme streamflow events (characterizing runoff response, e.g., routing attenuation, drainage densities, topography, biogeoclimatic zone and other factors). Lakes and wetlands can attenuate runoff (slow down runoff). Focus has often been on hydrologic responses to spring snowmelt, but precipitation events should be considered.
    - Harmful sediment.
    - Compromised riparian function.
  - GIS-based indicators:
    - Biogeoclimatic Unit Area Indicator.

        - Area contributing snowmelt runoff to spring flows (delineated using biogeoclimatic subzones).
        - Area still having snow after April 1st.
        - Snow contributing area and watershed hydrology.
        - Land use factors (e.g., equivalent clearcut area):
            - Accounts for urban, agriculture, mines, right-of-ways, pipelines, transmission lines, railways, cutblocks, and burned areas).
        - Cumulative effects.
    - Consequence, GIS indicators of key water values:
        - Water quality.
        - Infrastructure and human safety.
        - Fish.
        - Aquatic ecosystem health.
- Hazards and consequences are given relative weightings.
- Idea is to use the tool to assess hazards upstream of the elements at risk that you are interested in.

3.4.1.3 Post-Wildfire Assessment

- Burn severity mapping is the first step.
- Burns severity classes are unburned and low, medium and high severity.
- Need to identify priority areas for immediate attention. Priority elements from a fish and fish habitat perspective in view of the Wildfire Playbook:
    - Private property and human safety.
    - BC MOTI infrastructure (roads, bridges etc.)
    - Inform salvage response.
- Identify areas of long-term management concern:
    - Recovery and rehabilitation efforts for fish and aquatic habitats.
- The assessment informs the response.
- Do not replace field-based assessments.

3.5 EN ROUTE TO THE WILDFIRE RECOVERY PLAYBOOK (PRESENTATION #9)

Presenter	**Jeff Morgan**, M.Sc. Consultant to the Pacific Salmon Foundation
Title and Link to Video	*En Route to a Watershed Recovery Playbook*
Slide Deck	Appendix Figure 9

3.5.1 KEY MESSAGES

3.5.1.1 Background and Vision for the Wildfire Playbook

- There are 50 Pacific salmon populations that are currently under consideration for listing under the federal *Species at Risk Act* or pending assessment by the Committee on the Status of Endangered Wildlife in Canada (DFO–PSSI News Release 2021).
- For the South Coast, the Committee on the Status of Endangered Wildlife in Canada has listed 48 populations (Chinook salmon, coho salmon, sockeye salmon or steelhead trout) as Special Concern, Threatened, Endangered or Extinct.

3.5.1.2 Salmon Declines and the Importance of Freshwater Habitats

- Anthropogenic impacts to fresh waters that salmon rely on for reproduction.
    - Habitat alterations, pollution, water withdrawals, barriers to movements, invasive species.
    - Cumulative effects (sum total of all impacts).
- Freshwater rearing species account for almost all of the BC's salmon populations that are at risk.
- Compared to marine environments, freshwater environments are unstable (conditions fluctuate widely).

3.5.1.3 Amplification of Existing Cumulative Effects by Current Wildfire Regime

- The frequency and severity of catastrophic wildfires are increasing due to climate change.
- Wildfires compound climate change impacts by, for example:
    - Removing cover.

- Exposing sediment.
- Altering water chemistry.
- Affecting water temperature.

3.5.1.4 Values and Capacity

- People value watersheds for a wide variety of reasons: water, fish, recreation, aesthetics, spiritual/cultural.
- Our understanding of watershed function is steadily increasing.
- Individuals, governments, industry and NGOs want to participate in fish protection and conservation.
- There is increasing capacity within First Nations.

3.5.1.5 Wildfire Playbook Objectives and Scope

- To guide landscape recovery strategies and priorities for salmon habitat following major wildfires.
- The Wildfire Playbook's target audiences are the forest industry, government agencies, First Nations, NGOs and planning teams.
- It will provide technical advice and/or recommendations regarding responses to major wildfires from a fish and fish habitat perspective.
- It will be a technically and scientifically sound document that will apply to western North America and especially to those regions that are at risk for major wildfires.
- The Wildfire Playbook will provide a strategy that will:
    - Describe salmon habitat requirements, watershed process and the impacts of wildfires on fish habitat.
    - Guide the acquisition of existing geospatial information, scientific and technical information, assessment and monitoring techniques, policy and BMPs, and Indigenous knowledge.
    - Provide priority setting and decision-making support tools (treatments, integrated planning and operational environments) ensconced in multi-government (G2G), multiagency and stakeholder settings to account for different worldviews, and risk management and adaptive management framework.

3.5.1.6 Governance of the Wildfire Playbook Project

- The direction and content of the Wildfire Playbook will be informed by a Management and Advisory Committee, a Working Group, and an Advisory Body.
- The Advisory Committee and the Working Group will include representation from BC FLNRORD, Fisheries and Oceans Canada, a First Nations organization and the PSF.
- The Advisory Body will include about 30–50 individuals with expertise in fish habitat, hydrology/geology, forest operations, integrated G2G planning, IT and IK. Representation will be sought from BC FLNRORD, Ministry of Environment and Climate Change Strategy (BC MOECCS), Fisheries and Oceans, First Nation organizations, academia, industry, NGO and the PSF. The Advisory Body will perform a review function which will feed up to the working group.
- At this point, the Advisory Body membership has not been established.

3.6 AFTERNOON FACILITATED DISCUSSION

Panel Members	**Jason Hwang** Vice President, Salmon, Pacific Salmon Foundation **Eric Valdal** BC Ministry of Forests, Lands, Natural Resources Operations and Rural Development **Sarah Dickson-Hoyle** University of British Columbia, Faculty of Forestry **Doug Lewis** BC Ministry of Forests, Lands, Natural Resources Operations and Rural Development **Jeff Morgan** Consultant to the Pacific Salmon Foundation **John DeGagne** BC Ministry of Forests, Lands, Natural Resources Operations and Rural Development and Society for Ecosystem Restoration in Northern BC **Rachael Pollard** Association of BC Forest Professionals
Video Link	*Afternoon Panel Discussion: Workshop on Salmon Watershed Recovery in Post-Wildfire Environments*

3.6.1 EXPERT PANEL REMARKS AND RESPONSES TO SLIDO QUESTIONS

To recap the afternoon session, Jason Hwang invited participants to share their thoughts and to comment on what they heard.

Eric: Common threads from this afternoon were solution-oriented and provided good guidance for the future. There were different levels of presentations that were a good starting point for this conversation today.

Sarah: Seeing common threads as well, including the importance of identifying tools and assessment techniques, but ensuring joint planning and involvement from the beginning.

Rachael: Excited that this group is meeting. In talking with Jeff, I shared how challenging it was to work in the middle of the process to build relationships and figure out what should happen and where. The idea of a Wildfire Playbook is not meant to box anyone in but is for sharing information. Things happen very fast and we were not always sure of what we should or could be doing. The Wildfire Playbook would be helpful for those faced with the questions of what they should or could be doing for fish and fish habitat for the land base.

Sarah: Wildfire Playbook is a list of ingredients rather than a full recipe. A suite of tools in different contexts and at the site-specific level.

John: We can't stop trees from regrowing on our sites. Vegetation rebounds so quickly in my location, but that does not occur everywhere. Any process needs to be at an appropriate scale to manage differences in ecosystems, differences with people, stakeholders, First Nations, etc. Scale is a consideration from different perspectives.

Jeff: Grateful for all the presentations and the dialogues. We are not starting from zero for the Wildfire Playbook. There has been a lot of work done on G2G relationships, effective planning, planning tools, GIS, etc. We heard a lot about different techniques to recover a watershed, we also heard some of the science around hydrology and geomorphic risk. The Wildfire Playbook should be about bringing together all the information and making it readily accessible for anyone having to coordinate a team or planning process.

Doug: There is a need to think of recovery over the long term. Establishing the zones and setting objectives for what you want to achieve in those zones and ultimately monitoring. We have the ability to spatially establish some objectives that could be valuable for fish and watersheds is a key part. Lots more work to do and to continue with even multiple years after the fire.

SLIDO QUESTION: Having a recovery Playbook is a great idea and an important tool, though it's reacting to the symptoms of other causes. Is the intention to pair this recovery Playbook with more proactive ecosystem/land-based management strategies?

Jason: From the PSF side, we agree with that point. We are trying to be clear that we are not trying to intrude upon government or First Nation authorities or jurisdictions. The idea is that there will be fires and people have good ideas out there that should be factored in. We thought it would be useful to assemble this information all in one place. The idea of pairing it would be sensible and logical, but this is our contribution to an overall toolbox available for anyone to use.

Jeff: This would need to be discussed by the management level steering committee. Ultimately, we would hope to provide a Wildfire Playbook that will fit within a broader framework of responses to fires, such as wildfire resilience and how that would play out silviculturally. Hopefully what we develop through the Wildfire Playbook process will define the scope for us more specifically.

Doug: This is a really good question. Having the Wildfire Playbook is great, but we have to recognize that it is usually a reaction to an event that has already occurred. It is also important that there are a lot of things we know we can do to adapt to climate change that are also good for fish and other things that are proactive. Like upgrading infrastructure (roads/bridges/culverts) to take on larger flows that we know are going to occur. We know that elevated stream flows move streams and debris, so it is important to have intact riparian areas. We can do these things proactively so that if and when the fire occurs there is less we have to react to.

Jason: **Is there anything a foot that is leading towards that that people here might want to know about? Or, is it an idea that is out there but doesn't have any detailed actions or measure to advanced it at this point?**

Doug: There are some actions ongoing within the forest industry and I would image they are proactive regarding updating infrastructure. As well, there are some initiatives to make people more aware of the alluvial fans and flood plans. Outside of that, things like riparian restoration on private land, I'm not as aware of any initiatives that way.

SLIDO QUESTION: Eric—Are there considerations made for allowing natural regeneration or planting alternative species, as opposed to planting crop species?

Eric: Follow up with Eric via email and he will link into with foresters. With regard to some key themes discussed at Elephant Hill, I interpreted the conversations as "*stop slamming pine in everywhere*." We worked with Secwépemc to design and figure out stocking standards that were culturally sensitive and ecologically sensitive. There was work done to figure out what are the desired future conditions, what values are we managing for, and how do we use silviculture to meet those conditions.

John: There are stocking standards and legal obligations held by licensees across the land base, and even though they have been burned the obligations are still exist over time. Other non-obligatory areas, have more room for natural regeneration of noncommercially species. In our area we leave a period of time between burning fire (3 or 4 years) before assessment and replanting. This allows natural processes to express themselves, and they usually do. In many cases we saved money and expense not having to plant as they re-generated on their own. Adjusting legal requirements of a licensee is a bit more difficult.

Sarah: Elephant hill was developing joint silviculture principals and including things such as species mix for reforestation. In sharing those figures with people from communities they were pleased there was much lower percentage of lodgepole pine compared to Douglas fir. SRSS has a real focus for riparian species such as willow, birch, alder and others like soapberry.

Jeff: I believe there was/is an ability under FRPA to change stocking standards depending on values and risk that are in play. Eric, Rachael or Sarah, is that correct?

Rachael: With the new exciting changes in legislation Bill 23 Forest Amendment Act include:

- the ability for the chief forester (government) to establish an area of catastrophic damage and make changes; and,
- forest landscape planning.

This will allow us to work with proactive planning where we can work in partnership with First Nations on what we want the land base to look like in the future.

Eric: There is a process to alter them through that process and addressing climate is a big piece of that. Not really qualified to speak to the details. There may be an opportunity to post a follow up from staff after this session.

Jason: The PSF would be willing to be an intermediate to get any information from any of our speakers out. Feel free to use us if you don't have the contact information for the people you want to get to.

SLIDO QUESTION: For Doug Lewis, how does all of your indicator-based work proof out on the land? I see that the elements at risk are half of the equation in your risk-based approach which is telling. Without an element at risk there is no risk, yes?

Doug: Those involved had a lot of experience with watershed assessments and based on their prior knowledge of systems. We also did some follow up after Elephant Hill looking at stream conditions after the wildfire. For the most part, the conditions really did play out consistent with the assessment procedure. In terms of elements at risk, there are elements at risk in every watershed. Using the results of this, we often just focus on the hazard ratings as our risk ratings. **When we think about consequence it takes into consideration the sensitivity of the element, exposure, vulnerabilities, is this fish stock particularly more valuable than somewhere else?** So we often focus on the hazard side of the equation and us that as risk.

SLIDO QUESTION: "Recovery" implies putting things back to the way things were - which Jeff acknowledged may not be possible (and maybe the baseline wasn't all that great to begin with). How does the "*build back better*" principle factor into this work?

Jeff: I liked the images that Gordon/Rebecca provide about understanding values on the land base from before versus most recently, and the fact that maybe what existed most recently was not ideal. We want to understand the values on the land base, what we want from the land base, how we manage it and approach it through a planning process that works for everyone. Then determine desired future states, what is possible, and what is cost effective, and the interplay between one objective and others.

Doug: Recovery implies not necessarily putting back things back to the way they were but recovering/functioning and how you want that to look. In the case of build back better, we may be able to take a system that has been so far pushed (blow out a bridge or section of road) and can re-establish the channel better by changing the road location and allow the functioning to improve.

Sarah: It comes back to are we talking about recovery or proactive restoration/management? We need to think about what are we recovery to? Ecosystem function, particular structures or composition, what is the historical trajectory or disturbance context.

Jason: From my desk at PSF, the intent was not to suggest that after a wildfire you need to rush out a put back what was there, but more to say there is a sense of a need to respond after a wildfire. There are concerns of negative effects. Forest companies do stuff, landscape managers do stuff, people go out and do stuff. The thinking behind a Wildfire Playbook was that conditions are changing from what we were used to (last 40 and 50 years) and it does not seem to be what we will be faced with in the future. We don't seem to have really good research we can go to. We have great watershed restoration manual developed 25+ years ago, but we are not sure they are necessarily valid today. Things are changing, people are going to do stuff, and can we provide some guidance that will help in terms of what are the needs of salmon and aquatic ecosystems.

SLIDO QUESTION: Is the "elephant in the room" not also that the Province of BC has no legal responsibility after wildfire or other catastrophic event to address the lose of watershed resilience?

John: There are some initiatives around managing watershed resilience. I think the government does have a responsibility, but things move slowly. Promotion of a Wildfire Playbook and the collaboration here are moving towards this. It is a little bit ad hoc and hopefully things have some focus provided to them and we are able to deliver something a bit more organized, objective driven, and we can feel like we are accomplishing something. It would be helpful to have upper-level direction and support for local level restoration activities.

Eric: There are many scales to consider this question. Someone with a house on an alluvial fan near a watershed affected, a FN community or community or professionals could ask this at the bottom of a watershed, which we've seen through cumulative natural effects and human-caused activities on the land base. I can't speak to the legal part of it, but I can say without hesitation that the government is very interested in amping up our game in collaborating with First Nation to figure out how we manage watershed security and healthy watershed. Over the last decade it has been a growing concern of government that has acted in different ways in different places with new objectives, working with communities, doing landscape-level work. The trend is that government is extremely interested in watershed resilience throughout the province.

Doug: Echo Eric's comments. There is great interest in the sense that when you look at the costs associated with catastrophic events occur, the cost to government, the direct costs as well as the cost to governments, First Nations and others in the values they are concerned about. Maybe it is a lot less expensive to do work up front and prevent them than to respond to them.

Wayne S (participant): This is something I've been chasing after for the last few years. I came out of wildfire services, which was the later part of my career. It has been something that we've been long concerned about. Building resilient forest is not a new thought, enacting it is terribly difficult process. After 2018 talked about the need for resilient forests and chief forester has been reluctant to change that from a timbered forest to a resilient forest or hardwood inclusive. We don't have a strategic overview after fires to do anything other than guard resilience, putting it to bed. I think it is overdue, it is bigger than salmon, it is also about communities and the whole landscape issue. The fire department in Cache Creek I believe has had its front doors opened twice after fires and that prompted something. The rest of the province we need the same urgency that is there is salmon and recovery is going to be dealt with. Pleased that our eyes are opening but it has been the last decade that has been a problem for us in a major way.

Jason: Thanks Wayne. I kind of put you on the spot there, but you have a lot of experience, wisdom and energy for these issues.

SLIDO QUESTION: For Doug Lewis, is there any plan to expand this GIS-based indicator approach to other regions? Or even province wide?

Doug: The approach I spoke to in the Thompson has also been replicated in the Cariboo and Omineca regions in the southern/central interior of the province. There is a province-wide program that is similar in terms of indicators and watershed assessments. The idea of multi-scale watershed is a bit more of a challenge at the province-wide scale.

SLIDO QUESTION: For Doug Lewis, which hydrologic recovery curve you are using in your latest version of GIS tool?

Doug: We are using the most recent hydrologic recovery curve developed by Rita Winkler and others in the assessment. Generally, it takes a lot longer for stands to recover than the original recovery curve.

SLIDO QUESTION: For Jeff, there are existing "Playbooks" out there that could be used to achieve the objectives you've laid out. Why start from scratch when so much has already been done? In the Kamloops TSA, we used the Elephant Hill guidelines as our Playbook for our salvage retention plan. Is the 'Playbook' that is being proposed going to be built off of those guidelines or will this be a re-invention of the wheel?

Jeff: There is a lot of guidance out there, and examples like watershed restoration planning and priority setting guidelines and emphasis on fish habitat, watershed-based fish sustainability planning conserving BC fish population, watershed assessment and management of hydrologic and geomorphic risk in the forest industry, and burned area emergency response treatments, and there is the direction on where one might salvage and where not and how one does so. There are a lot of documents out there, and they are all very good. We would not propose that we start from scratch. We are looking to the community to bring together the most salient guidance that is out there. Really looking for the development of a Wildfire Playbook that would not be a re-write of all those documents, but instead tell the general story of a river or watershed and identify everything one might need to know about how they would participate in a watershed recovery process. It would talk about the story of the river/watershed, the tools available, information sources, existing guidelines, decision support, etc., all brought together in one Wildfire Playbook.

Hoping to keep it between 50 and 80 pages and would provide references to the various good guidance already out therein electronic format and allow us to take advantage and leverage on all the information that is out there. New science is coming along, new legislation is coming along, and we want to build that in as well. People have asked about the GIS tools, and they are evolving all the time. Building decision-making support as well. There is a lot of room to build one document that can provide the general overview of the kind of things we need to know about. It will not be a deep dive on everything that will be involved in recovering watersheds. It will be a reference document to allow people to understand the breadth of the problem and where they can go to seek additional information.

The chief forester's guidelines on salvage activities for the Elephant Hill Fire is a standing BMP to acknowledge and take advantage of. There is room to describe the sequence or order of events that happen through a river or watershed recovery to think about how we sequence our activities over time. Right after a fire we might need to address risks to

infrastructure, stabilizing slopes, seeding such that we are minimizing erosion versus those things that might be tackled 10 to 20 years out where we think about channel morphology.

Jason: The intent of what we are undertaking at PSF is not to reinvent the wheel, but as far as we are aware there is no on one place where all of the best information is brought together that could be used t to inform things on the landscape after fire that would help salmon. Lots of great stuff out there that we could assemble to make it easily accessible and useful for people.

Eric: The chief forester's post-natural disturbance retention guidance is in play for the whole province, not just for Elephant Hill.

Jason: **I will give our panel members a last word, something really brief. Thank you for your time today. Are there any last thoughts or ideas you would like to make or sharpen?**

Doug: Thank you for the opportunity to present. Like where the Wildfire Playbook is going.

Jeff: Thank you to the participants and presenters. Please reach out through the PSF website to get involved.

John: Capacity is an issue in all sectors for delivery of things and appreciate PSF for stepping up to provide leadership here. It is great and appreciate the capacity and if that can be directed to local solutions around these issues, I think it very welcomed.

Sarah: Thanks for the opportunity and invite to present. The SRSS, and others, are excited to hear about the opportunities to be involved.

Eric: Appreciate and support the goal of the workshop today. Since we all had to skip over the pond a little bit, we've shown some nice tools here today. Whether it is for wildfire recovery or for managing the land base, we are using those tools in concert with multiple lines of evidence, inventories, assessments at different scale, and figuring out how to weave Indigenous knowledge and partnership into providing robust solutions.

3.7 CLOSING REMARKS

Presenter:	**Jason Hwang** Pacific Salmon Foundation
Title and Video Link:	*Closing Comments*

3.7.1 OVERVIEW

- It is recognized that wildfire is a natural process and that salmon and ecosystems are adapted to it but there is much change and much complexity (fire is not the only thing that is happening on the landscape). Thus, the Playbook must not tackle any one issue, one place or provide only one solution.
- Thankfully, there is a bank of knowledge, perspectives and experience to draw from as we move forward.
- It has been emphasized that we must work respectfully and effectively with First Nations and broadly across the landscape. We must also seek to collaborate and to develop a diversity of partnerships.
- There is much work to come on the PSF's Playbook Project through the Working Group and Committee processes that have been laid out.
- The PSF appreciates the complexity of the challenge and welcomes any further inquiries into this project.
- Thanks to all for your participation in, and contributions to, today's workshop.

APPENDICES

APPENDIX A WORKSHOP ATTENDANCE

Workshop attendance included individuals and representatives from the following organizations:

- Adams Lake Indian Band
- Aqua Environmental Associates
- BC Forest Practices Board
- BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development
- BC Ministry of Agriculture, Food and Fisheries
- BC Ministry of Transportation and Infrastructure
- BC Ministry of Environment
- BC Wildfire Service
- BC Wildlife Federation
- Burns Lake Community Forest Ltd.
- Canadian Wildlife Federation
- Canoe Forest Products
- CE Analytic
- Conservation Northwest
- Duhamel Watershed Society
- Eclipse Geomatics
- EDI Environmental Dynamics Inc.
- Fisheries and Oceans Canada
- Forest Enhancement Society of BC
- Geomorphic Environmental Services
- Gorman Bros. Lumber Ltd.
- Interfor
- Lhtako Dene Nation
- Little Shuswap Lake Band
- Live Long the Kings, Seattle
- Lower Nicola Indian Band
- Lower Similkameen Indian Band
- McLeod Lake Indian Band
- Natural Resources Canada
- Neskonlith Indian Band
- New Graph Environment
- Nlaka'pamux First Nation
- Nooaitch Band
- Ntityix Resources LP
- Nuxalk Nation
- Okanagan College
- Organization
- Oregon State University
- Outlaw Meats
- Pacific Salmon Foundation
- Polar Geoscience Ltd.
- Qwelminte Secwépemc
- Rivershed Society BC
- Saik'uz First Nation
- Scw'exmx Tribal Council
- Secwepemcúl'ecw Restoration and Stewardship Society
- Simon Fraser University
- Shackan Indian Band
- Shifting Mosaics Consulting
- Shuswap Nation
- Simpcw Resources Group
- SkeenaWild Convservation Trust
- Skeetchestn Indian Band
- Skeetchestn Natural Resources Corporation
- Splastin
- Split Rock Environmental
- St'at'imc Government Services
- Syilx Okanagan Nation
- Tolko
- Trails BC
- Trout Unlimited
- Thompson Rivers University
- University of British Columbia

- University of Northern British Columbia
- Upper Fraser Fisheries Conservation Alliance
- Upper Nicola Band
- United States Department of Agriculture
- Utah Government
- University of Victoria
- Watershed Watch Salmon Society
- WaterSmith Research Inc.
- West Fraser

APPENDIX B VIDEO LINKS

Direct URL links to all presentations are listed below.

Presentation Title	Presenter	Link
Opening Remarks	Jason Hwang	https://youtu.befsQmI7sUraB60
Attribution Science: Why the Flood Regime in BC is Super-Sensitive to Disturbances	Younes Alila	https://youtu.be/QB1-8rHp1QY
Geomorphic Response to Wildfire in British Columbia	Tim Giles	https://youtu.be/8PkoQsbX4G4
Wildfire: A Disturbance That Hits the Aquatic Habitat Reset Button?	Rebecca Flitcroft Gordon Reeves	https://youtu.be/AuSFFHE_XjE
Miller Time: Cheers to Partnerships and PBR	Nicole Nielson Jordan Nielson	https://youtu.be/BTPnK69cRtE
Morning Panel Discussion		https://youtu.be/HrVHToP9Gj8
Indigenous Leadership in Wildfire Recovery and Restoration, 2021	Char John Angie Kane Sarah Dickson-Hoyle	https://youtu.be/IJMtnru2lZ8
Post-Wildfire Landbase Recovery – An Overview of the Elephant Hill Initiative	Rachael Pollard Eric Valdal	https://youtu.be/VrEBXHao8iE
Shovel & Island Lakes Wildfire Ecosystem Restoration Plans: A Collaborative Approach	John Degagne	https://youtu.be/Hc2_AYm_6yI
A GIS Indicator-Based Approach for Rapid, Post-Wildfire Watershed Assessments	Doug Lewis	https://youtu.be/Gz8jb-D0gI8
En Route to a Watershed Recovery Playbook	Jeff Morgan	https://youtu.be/aHoPx79Basc
Afternoon Panel Discussion		https://youtu.be/Y0VE70jbCgg
Closing Remarks	Jason Hwang	https://youtu.be/ESlGxiYTkeQ

APPENDIX C PRESENTATION SLIDES

WILDFIRE AND FLOOD SENSITIVITY (PRESENTATION 1)

Attribution Science: Why the Flood Regime in BC is Super-Sensitive to Disturbances

Acknowledgments:

Current and previous members of my research lab who contributed and continue to contribute substantially to our research on the topic of forests and floods over the last 25 years. Current members: Joe Yu, Henry Pham, Robbie Johnson, Jangar Tsembel, Habeeb Yusuf, Hunter Rigatti, Shuxiang Yang, Nick Green, and Nick Mantegna.

Physics of Forests and Floods: Have we Gotten it Wrong?

"Forest hydrology has a sad history of being embroiled in controversies that never seem to get resolved. Forest hydrologists could be recruited to defend almost any side of a debate, because our confusion about the various processes and their interactions in forests and streams"

[Dunne, 1998, p. 795]

- A statement particularly true on the topic of forest harvesting, peak flows, and floods.
- These controversies have led to an ever increasing schism between science, public perception, and often management policies worldwide.
- The disagreement is acute over how the forests affect large events, in small and large watersheds.

Journal name is shown in yellow

- ***Dunne T. (1998, p. 795) "Critical data requirements for prediction of erosion and sedimentation in mountain drainage basins" (J. Am. Water Resour. Assoc.)***

Forests and Floods:
Vehemently Defended Age-Old Science Wisdom

1) **Forests have no effect on large floods**
2) **The larger the flood event the smaller is the effect of forests.**
3) **The larger the watershed the smaller is the effect of forests**

"Forest hydrologists generally agree that, although forests mitigate floods at the local scale and for small to medium-size flood events, ***there is no evidence of significant benefit at larger scales and for larger events****".*

Calder et al. (2007) ***(NATURE)***

Journal name is shown in yellow

- ***Bradshaw et al. (2007) "Global evidence that deforestation amplifies flood risk and severity in the developing world" (Global Change Biol.)***

- ***Bradshaw et al. (2009) "Flooding policy makers with evidence to save forests" (Ambio)***

A dogma Reinforced by a Century of Peer- Reviewed Literature

Labelled as a dogma by some, such wisdom had been reinforced by a century of peer-reviewed literature where the effect of harvesting on the magnitude of a flood event has been defined by:

Difference in the magnitude of the pre- and post-harvest floods when both are generated by the **same storm** in the rain environment, or **same melt season** in snow environment.

"Chronological Pairing" (CP) Framework

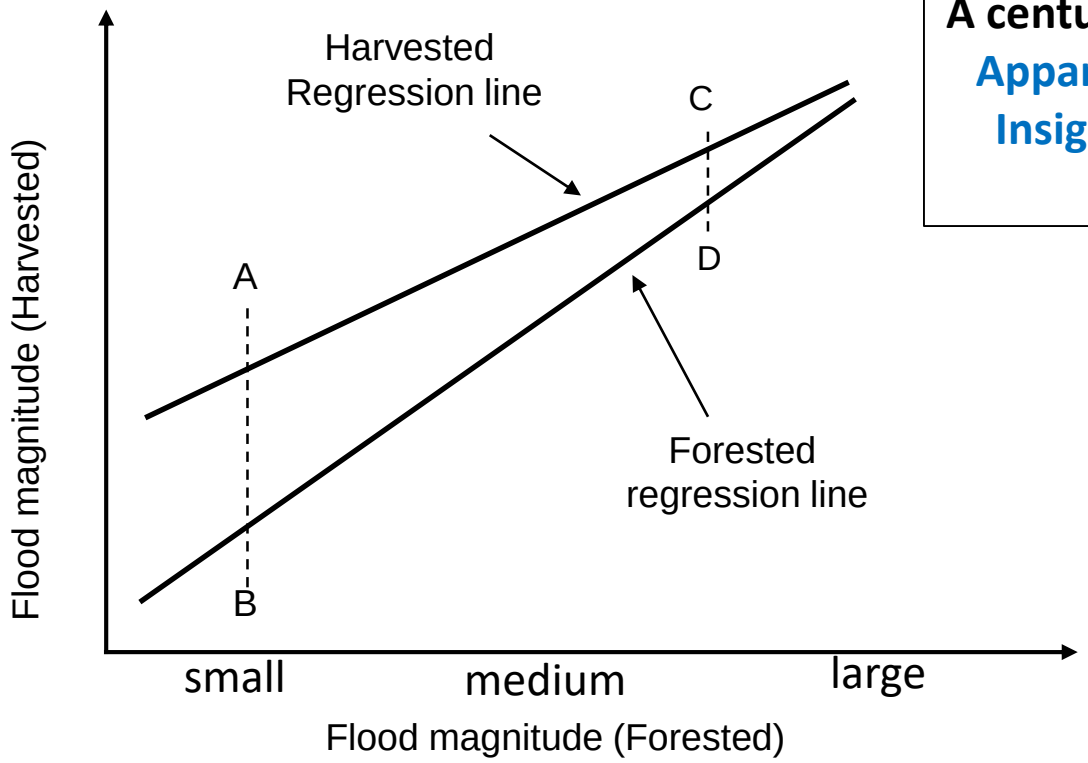
DOGMA

"We have long believed that forest cover by itself only can play a limited role in controlling peakflows due to extreme events. That is, an extreme rain event, spawned perhaps by a hurricane, would produce the same peakflows with or without forest cover, assuming all other conditions, especially soil conditions, were maintained"

DeWalle (2003, p.1255)

(Hydrol. Processes)

CP Framework Uses Regression for Prediction (does not invoke changes in frequency)

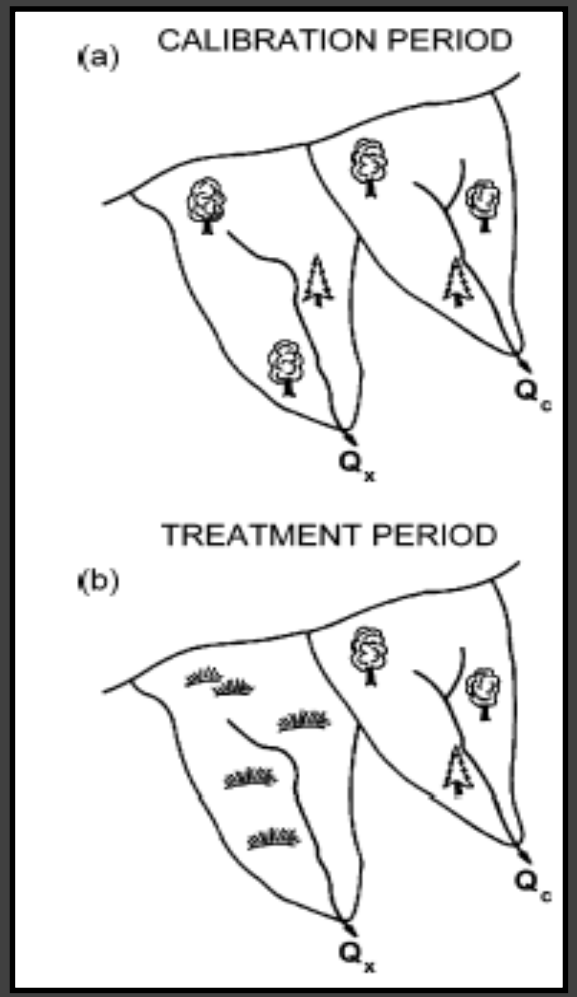


A century of Convergence = Apparent Evidence of an Insignificant Effects on Large Flows

- Old CP design protocol hindered the progress of science on the practically important larger watersheds, where these conditions cannot be met.

Old CP Design Protocol

- Uses a pair of experimental control-treatment watersheds small, in close proximity, and of similar enough physiography and meteorological input



Physical Explanation Used in Support of the Old Wisdom
(Note the CP line of reasoning)

"…During the largest rain or snowmelt events the soils and vegetative canopy will have little additional storage capacity, and under these conditions much of the rainfall or snowmelt will be converted to runoff regardless of the amount or type of vegetative cover."

Journal name is shown in yellow

MacDonald & Stednick (2003, p. 13),
"Forests and water: A state of the art review for Colorado"
(Colo. Water Resour. Res. Inst., Fort Collins)

WATER RESOURCES RESEARCH, VOL. 45, W08416, doi:10.1029/2008WR007207, 2009

Forests and floods: A new paradigm sheds light on age-old controversies

Younes Alila,[1] Piotr K. Kuraś,[1,2] Markus Schnorbus,[3] and Robert Hudson[1]

Received 9 June 2008; revised 15 April 2009; accepted 30 April 2009; published 13 August 2009.

Alila et al. (2009) called upon the Forest Hydrology community to abandon the old and adopt instead the following definition for the effect of harvesting:

Difference in magnitude of pre- and post-harvest floods when both are of the **same frequency**

"Frequency Pairing" (FP) Framework

- Alila et al. (2009) called for a reevaluation of past studies and the century-old paradigm that shaped the science perception of forests, floods, and the biophysical environment.

In this and subsequent papers, our analyses of long-term pre- and post-harvest peak flows using FP and CP led to diametrically opposite outcomes

- **Harvesting affects not only small and medium peak flows but also the larger events**

Pairing: The Foundational Tenant of Experimental Design

What is Wrong with CP?

- CP not designed to evaluate changes in frequency, but most importantly results in an incorrect measure of the effects of harvesting on the magnitude of floods. In short, CP leads to irrelevant outcomes.

- This is because the magnitude of a flood event is controlled by the **simultaneous** and **random** occurrence of several factors: In rain environment: 1) storm & 2) antecedent soil moisture condition; In snow environment: 1) snowpack on the ground, 2) energy available for melt, 3) rain falling on melting snow, and 4) antecedent soil moisture conditions.

- Fixing these factors one at a time, *ceteris paribus* (e.g., pairing by equal storm input) leads to an **uncontrolled experiment** that does not **isolate** the effects of forest harvesting on floods.

Journal name is shown in yellow

Alila & Green 2014
(Water Resources Research)

Yu & Alila 2019
(Forest Ecology & Management)

CP IS NON-CAUSAL

Not Designed for Investigating Cause-Effect Relations

CP Leads to Uncontrolled Experimental Design

Cartwright (1983) provides an around-the-kitchen-table example for why *ceteris paribus* experimental designs, must not be used for investigating real-life **multivariate** cause-effect relations:

> *"For example, (ceteris paribus) adding salt to water decreases the cooking time of potatoes; taking the water to higher altitudes increases it. Refining, if we speak more carefully we might say instead, 'Adding salt to water while keeping the altitude constant decreases the cooking time; whereas increasing the altitude while keeping the saline content fixed increases it'…. But neither of these tells what happens when we both add salt to the water and move to higher altitudes."*

Cartwright (1983) *goes on to say:*

> *"Seldom outside of the* ***controlled conditions of an experiment*** *are we in a situation where* ***a cause can legitimately be inferred****."*

On Ceteris Paribus Laws

Cartwright (1983)

"How the Laws of Physics Lie"

The Analogy:

For instance, in rain environment the magnitude of a flood is controlled by the storm and antecedent soil moisture conditions (AMC)

Flood = Cooking time of potatoes
Storm = Salt
AMC = Altitude

In our case, the causes of a flood are not only multiple but also chancy

CP Turned the State of Science "Enigmatic"

In 1930, Lowdermilk, an American forester, wrote:

> *"The literature on the influence of forests and vegetation on stream flow, flood control, and erosion covers a period of more than a century, is found in all languages of the modern nations, and totals several thousand separate publications, many of which are* ***difficult or impossible to consult****....Comparatively* ***few scientific studies have been made****, because of the* ***inherent difficulty of isolating variables from the complex of interacting factors in watersheds.****"* (Lowdermilk, 1930; boldface added for emphasis only.) end of quote

Until recently, and after a century of research and experimentation in forest hydrology that generated a body of literature grown much larger, this quote would still be valid. Its substance captures remarkably well the seemingly eternal **"enigmatic"** nature of the state of science (as characterized by Eisenbies et al. 2007, p. 81).

Lowdermilk (1930)

"Forest and agricultural influences in streamflow and erosion control: Summary review of literature up to 1930. Washington, U. S. Dept. of Agriculture."

Eisenbies et al. (2007)

"Forest operations, extreme flooding events, and considerations for hydrologic modeling in the Appalachians—A review" (Forest Ecology & Management)

Why research question must invoke frequency?

In snow environment, for instance, the magnitude of a flood event is controlled again by 4 factors:

i. *snow accumulating on the ground*
ii. *energy creating the melt*
iii. *rain falling on melting snow*
iv. *antecedent soil moisture conditions*

*Many combination scenarios of these four factors, which all occur **randomly**, could generate the same peak flow event magnitude. Therefore, every peak flow event occurs with **a certain frequency**. Disproving such a peak flow event has not changed in magnitude because of harvesting, ought to be conducted for every one of these combination scenarios and simultaneously.*

Therein lies the reason why the question that guides research on forests and floods should be:

What is the difference in magnitude of pre- and post-harvest floods when both are of the same frequency, and not of equal chronology?

Simply put:

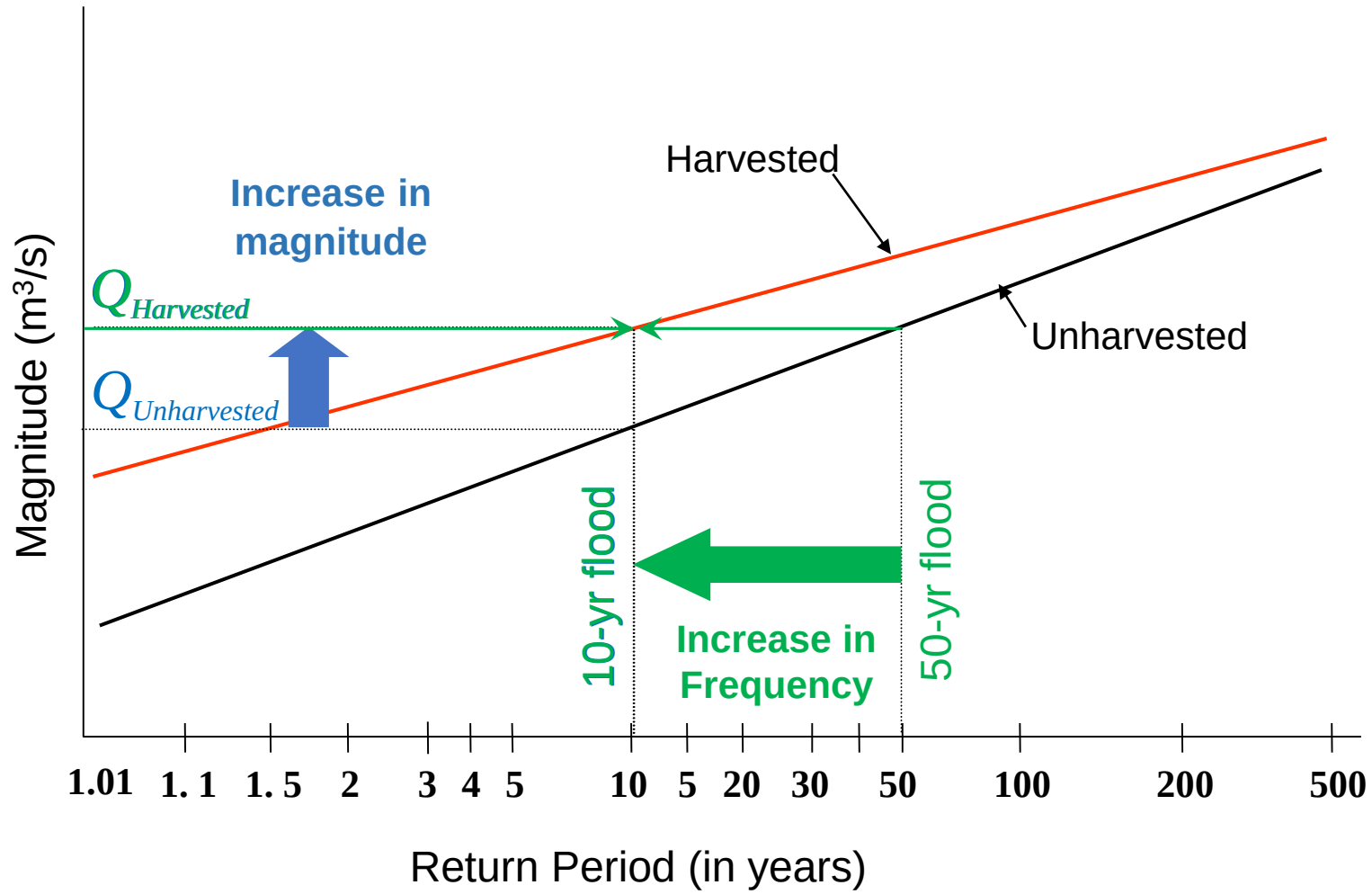
Causes are multiple and chancy

"The vitality of a branch of science is a reflection of the magnitude or importance of the questions on which its students are applying their effort"

Leopold, L. B. & Langbein, W. B. (1963)

FP Uses Frequency Distributions for Prediction

(Invokes magnitude & frequency simultaneously)



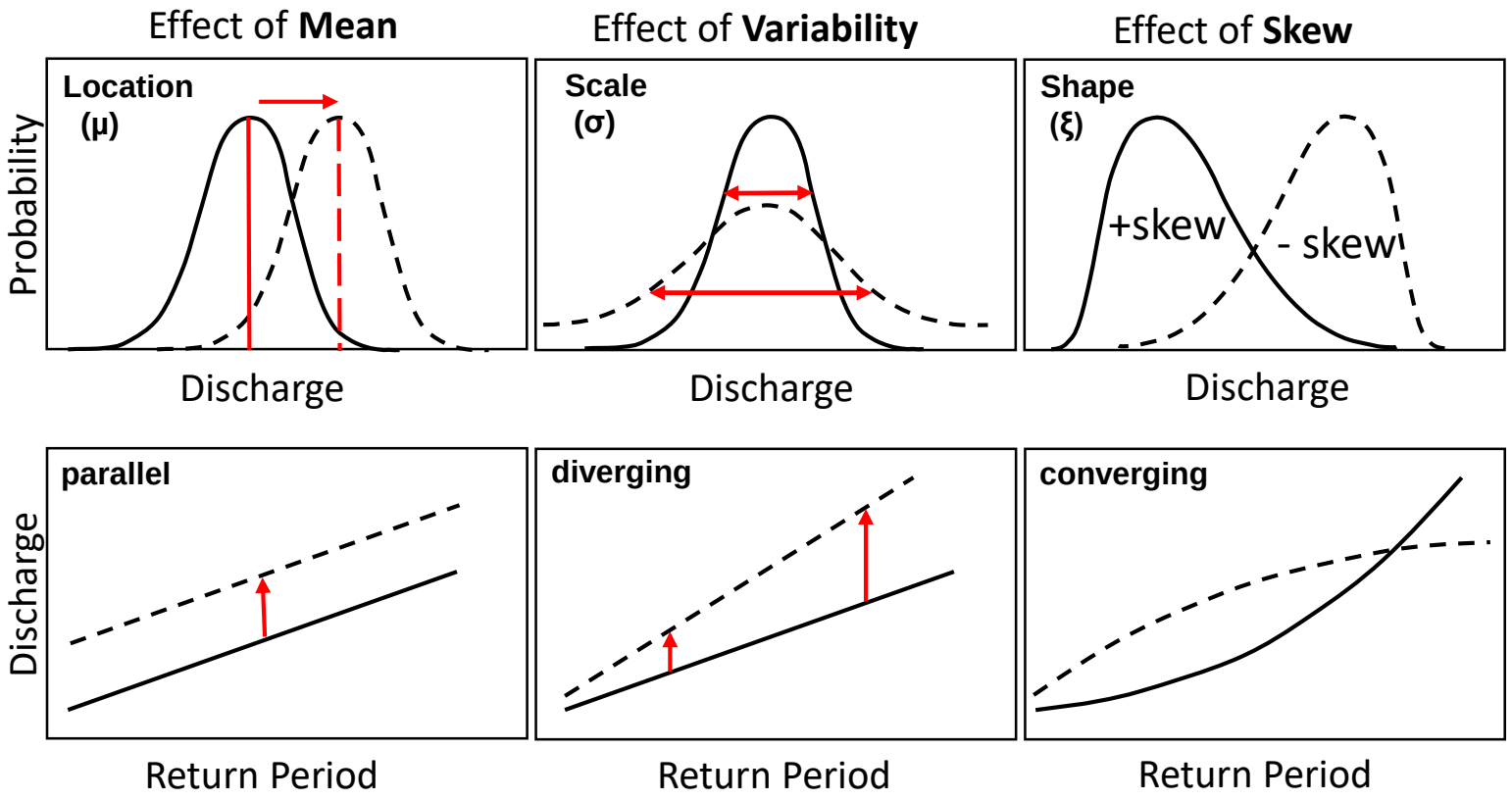
"Causality" by Judea *Pearl* 2009, University of California Los Angeles

- ***transformed causality from a nebulous concept into a paradigm in its own right with significant applications across many disciplines***

"Does Climate Change Cause Extreme Weather Events? by Frischkorn 2017, ***Smithsonian Magazine***

- ***early applications in climate change science generated a rigorous debate triggering the launching of a new field of research now commonly known as Attribution Science***

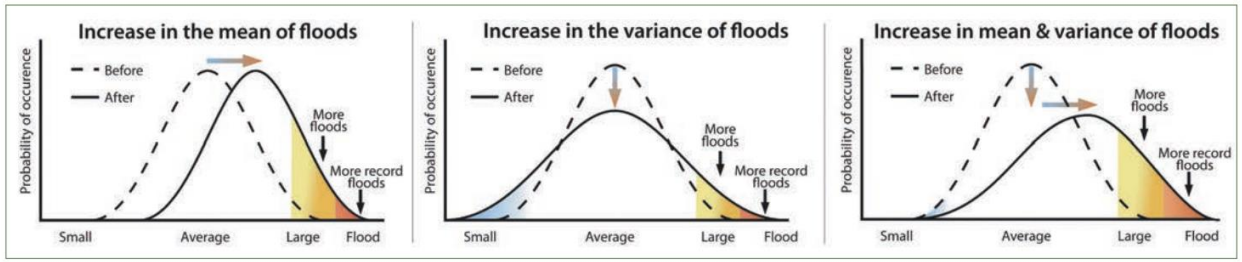
Environmental Controls on Flood Frequency Distributions
Pre-Disturbance Conditions



"The flood frequency curve represents one of the most comprehensive and compact descriptions of a catchment's storm response. It is the culmination of interactions, across both time and space, between climatic inputs, that is, rainfall influxes and evaporative effluxes (radiant energy), and properties of the catchment's landscape, for example, topography, soils, and vegetation [Robinson and Sivapalan, 1997, p. 2981].

Idiosyncrasies of the Science of Extremes

I. Extremes are sensitive to small changes in mean, variability, and skew of the frequency distribution



- The magnitude and especially the frequency of extremes are highly sensitive to small changes in the mean and/or variability and/or skew of the frequency distribution.
- Extremes are more sensitive to a simultaneous increase in the mean and variability of the frequency distribution than in its mean alone.
- Whether disturbance has increased the mean alone, increased the mean and decreased the variability, or increased the mean and variability; the larger the extreme event the more frequent it may become.

Journal name is shown in yellow

Wigley 1985
(Nature)

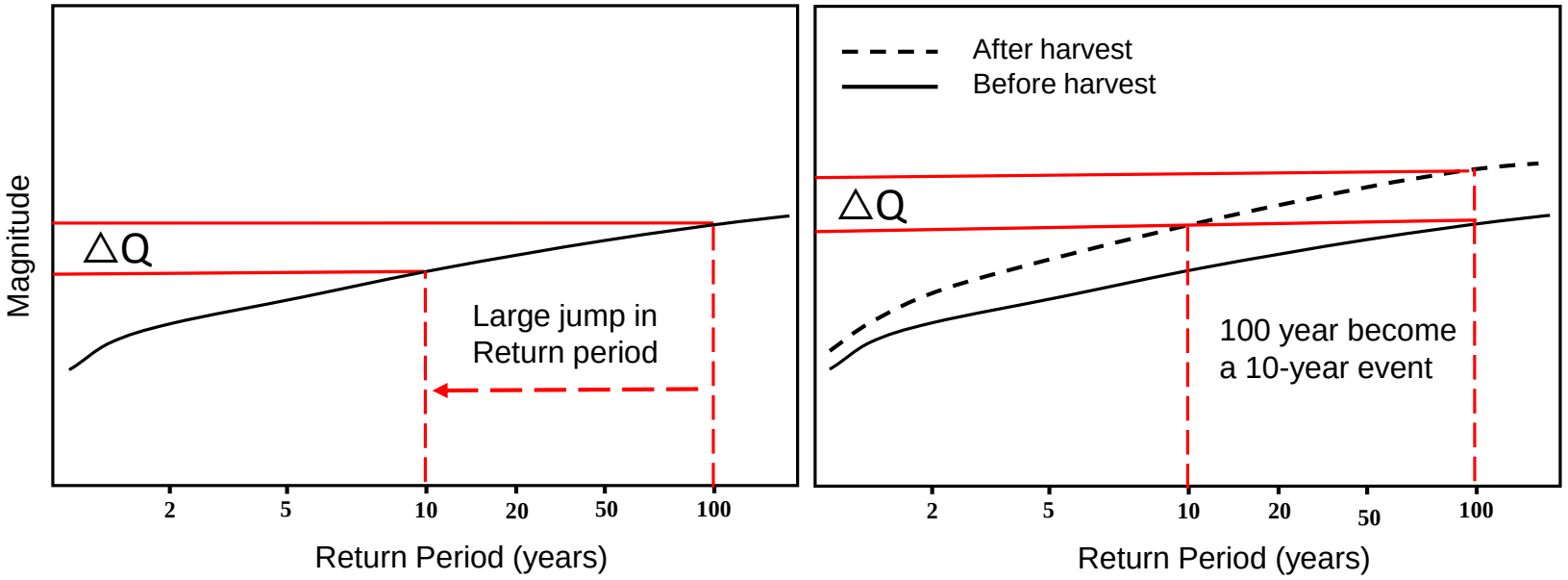
Katz & Brown 1992
(*Climate Change*)

Schaeffer et al. 2005
(*Climate Dynamics*)

Wigley 2009
(*Climate Change*)

Idiosyncrasies of the Science of Extremes

II. Extremes are super-sensitive to disturbances when the frequency distribution is mild in slope and concave in shape



- Flood frequency distributions in BC are characterized by a mild slope and a concave shape, long-recognized signatures of our hydro-climate dominated by nival and frontal storm-type pluvial regime.

- Small change in the magnitude of the large floods translate into large jumps in their return periods

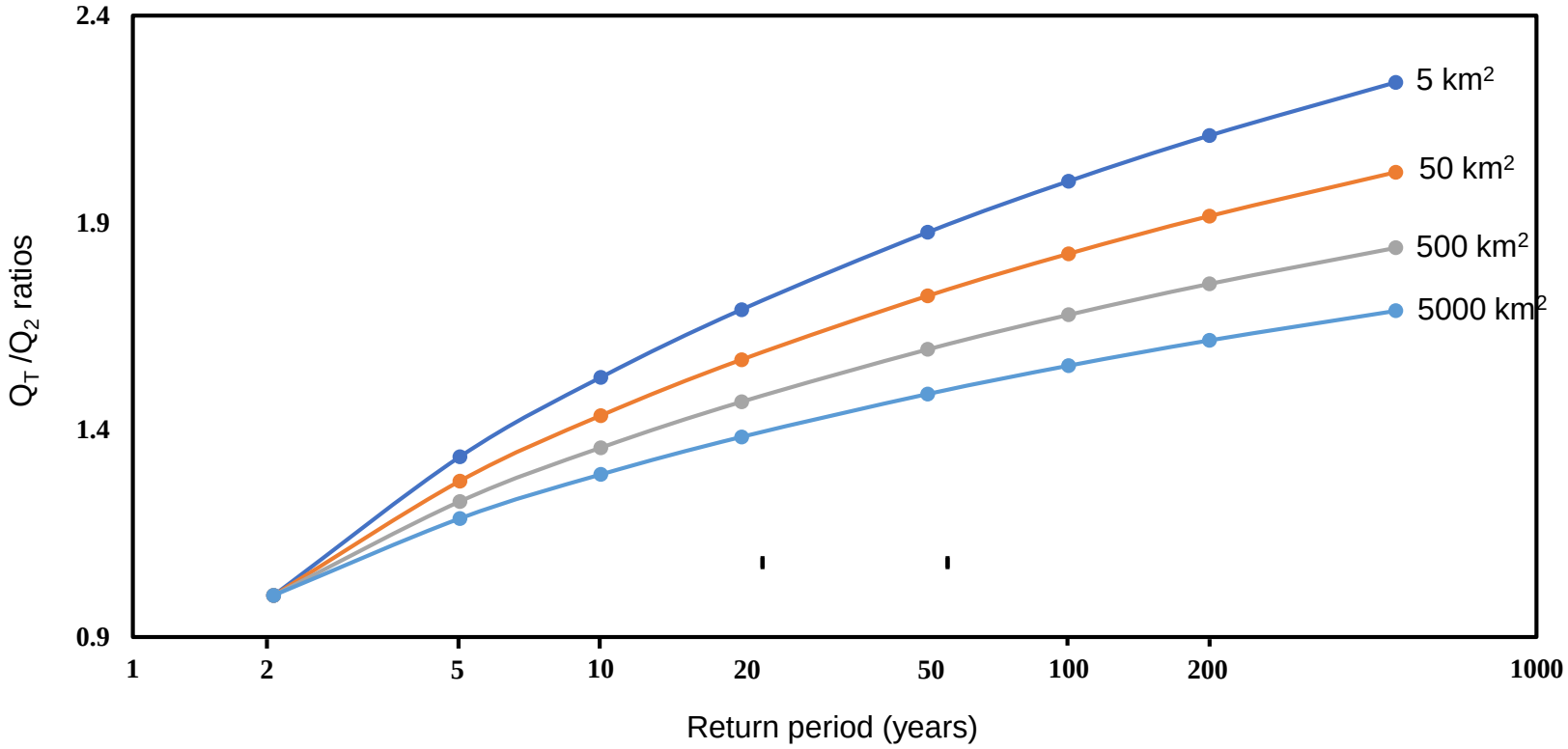
Journal name is shown in yellow

- **Even modest disturbance-induced increase in the magnitude of such floods results in surprisingly large increase in their frequency.**

Allen & Ingram 2002
(Nature)

Idiosyncrasies of the Science of Extremes

III. Larger watersheds can be more sensitive to disturbances than their smaller, upstream headwater tributaries



Why larger watersheds have a milder slope flood frequency distributions?

Runoff is delivered to the outlet more efficiently in smaller watersheds – this is why typically unit discharges decrease with an increase in the size of watersheds.

- **Larger elevation ranges**
- **Wider range of aspects**
- **More opportunity for below and above surface storages**
- **Desynchronization of flows from various tributaries**

Idiosyncrasies of the Science of Extremes

IV. Disturbances can affect extremes across all return periods (i.e. a no-effect threshold flood size may not even exit)

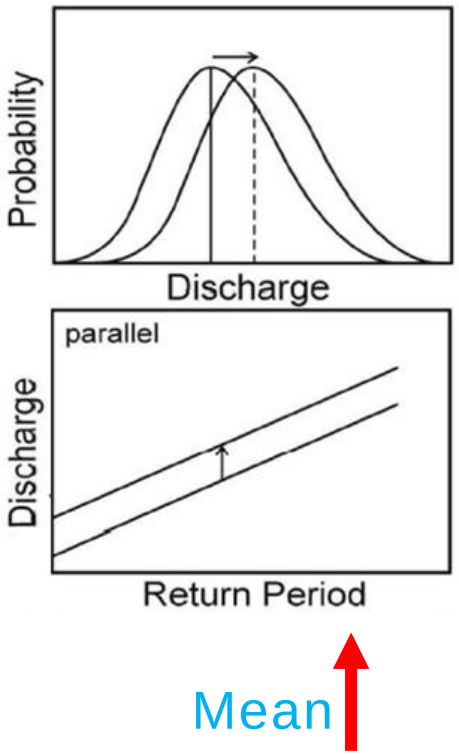
Table 5-1 Stochastic hydrology studies illustrate that only moderate changes in the mean and variability are required to induce substantive changes in frequency for large events. In cases where changes in the mean and/or variability were not explicitly reported, qualitative values were assigned (e.g., minor increase/decrease).

Author	Climate regime	Data type	Land-use change	Δ mean	Δ variability	Effect on flood frequency
Alila et al. (2009)[a]	Snow	Empirical	40% area harvested	+30%	-23%	Δ from 30yr to 14yr event
Birkinshaw et al. (2011)	Rain	Simulated	100% forested area harvested	< than a 2x increase	Minor increase	4x increase in 100yr event, nearly 10x increase in 1000yr event
Duncan (1995)	Rain	Empirical	Comparison between pasture and pine-covered catchments	3x increase	Minor increase	10x increase in 50-year event
Green & Alila (2012)	Snow	Empirical	33% to 40% area harvested in four catchments	+35%, +23%, +15%, +11%	+1%, -12%, +19%, +18%	Δ from 20yr to 10yr, 20yr to 12yr, 50yr to 13yr, 50yr to 30yr event
Kuras et al. (2012)	Snow	Simulated	50% area harvested	+9%	Minor increase	5-6.7x increase in 100yr event
Reynard et al. (2001)	Rain	Simulated	Afforestation to mitigate climate change impacts	-10%	Minor decrease	10x decrease in 50yr event
Schnorbus & Alila (2013)	Snow	Simulated	50% area harvested	+21%	+13%	20x increase in 100yr event
Yu & Alila (2019)	Snow	Empirical	24% area harvested	+31%	+10%	4x increase in 100yr event

[a] Only values for the 48-year record at Fools Creek were reported

Johnson R. (2021) "Nonstationary stochastic paired watershed approach: Investigating forest harvesting effects on floods in two large, nested and snow dominated watersheds in BC, Canada, Master Thesis Dissertation, University of British Columbia, Vancouver, Canada (108 pages)

Forest Disturbance - Flood Regime Relations
Emerging Probabilistic Physics



Disturbance-induced

1) Suppression of evapotranspiration,
2) Increases in the amount of energy available for snowmelt,
3) Synchronization of runoff
4) Soil disturbances.

ALL of which contribute to increasing amount of moisture available for runoff, combined increase the mean of the flood frequency distribution

Journal name is shown in yellow

Green & Alila 2012

"A paradigm shift in understanding and quantifying the effects of forest harvesting on floods in snow environments"
(Water Resources Research)

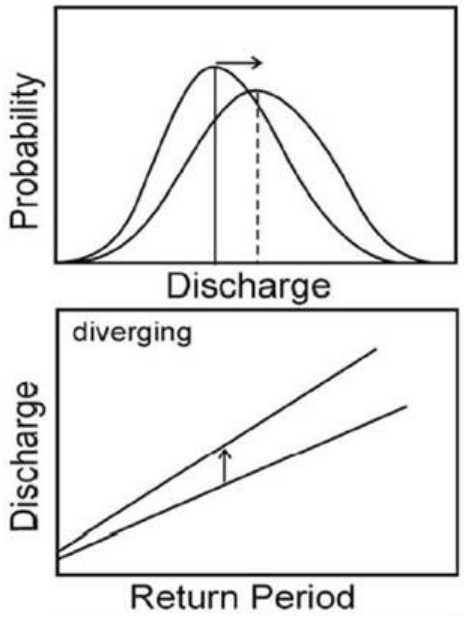
Rong & Alila 2022

"Frequency Pairing in Rain-on-Snow Environment Challenges a Long-Standing Paradigm in Forest Hydrology"
(Under Review)

Pham (2021)

"Frequency pairing reveals how large peak flows can be highly sensitive to forest treatment in rain environment: impacts increase nonlinearly with event size" (Master Thesis Dissertation, UBC Forestry)

Forest Disturbance - Flood Regime Relations
Emerging Probabilistic Physics



Disturbance-induced

1) Wetter soil (suppression of ET)
2) Disturbed soils
3) Synchronization of runoff
4) Increases in the amount of energy available for snowmelt,
5) Forest roads (subsurface runoff interception by cut-banks and increase in stream density).

Mean ↑
Variability ↑

ALL can increase the efficiency of delivery of runoff to the watershed's outlet, which increase not only the variability, but potentially the skewness.

Journal name is shown in yellow

Green & Alila 2012

"A paradigm shift in understanding and quantifying the effects of forest harvesting on floods in snow environments"
(Water Resources Research)

Rong & Alila 2022

"Frequency Pairing in Rain-on-Snow Environment Challenges a Long-Standing Paradigm in Forest Hydrology"
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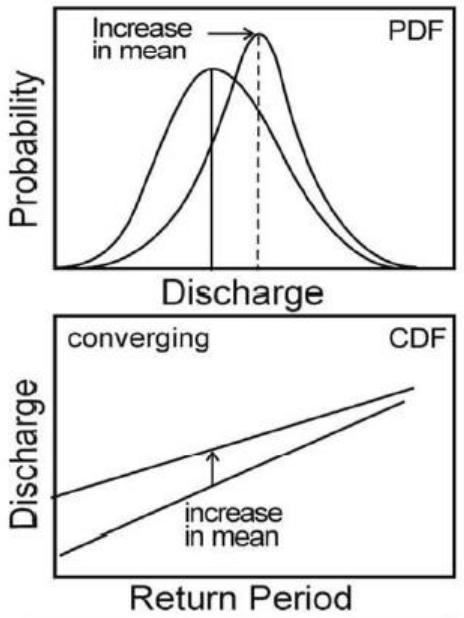
Forest Disturbance - Flood Regime Relations
Emerging Probabilistic Physics



Disturbance-induced

1) Desynchronization of runoff – we expect this to occur more so in the snow and snow transient environments.

Mean ↑
Variability ↓

Desynchronization of melt can decrease the efficiency of delivery of runoff to the watershed's outlet, which in turn decreases the variance, and potentially the skewness.

Journal name is shown in yellow

Green & Alila 2012

"A paradigm shift in understanding and quantifying the effects of forest harvesting on floods in snow environments"
(Water Resources Research)

Rong & Alila 2022

"Frequency Pairing in Rain-on-Snow Environment Challenges a Long-Standing Paradigm in Forest Hydrology"
(Under Review)

Pham (2021)

"Frequency pairing reveals how large peak flows can be highly sensitive to forest treatment in rain environment: impacts increase nonlinearly with event size" (Master Thesis Dissertation, UBC Forestry)

Our FP-based Publications Since 2004

1. Schnorbus, M., Alila, Y. (2004). Forest harvesting impacts on the peak flow regime in the Columbia Mountains of southeastern British Columbia: An investigation using long-term numerical modeling. Water Resour. Res. 40, W05205.
2. Alila, Y., Kuraś, P. K., Schnorbus, M., & Hudson, R. (2009). Forests and floods: A new paradigm sheds light on age-old controversies. *Water Resources Research*, *45*(8).
3. Alila, Y., Hudson, R., Kuraś, P. K., Schnorbus, M., & Rasouli, K. (2010). Reply to comment by Jack Lewis et al. on "Forests and floods: A new paradigm sheds light on age-old controversies." *Water Resources Research*, *46*(5), W05802.
4. Kuraś, P. K., Alila, Y., & Weiler, M. (2012). Forest harvesting effects on the magnitude and frequency of peak flows can increase with return period. *Water Resources Research*, *48*(1).
5. Green, K. C., & Alila, Y. (2012). A paradigm shift in understanding and quantifying the effects of forest harvesting on floods in snow environments. *Water Resources Research*, *48*(10).
6. Alila, Y., & Green, K. C. (2014a). Reply to comment by Birkinshaw on "A paradigm shift in understanding and quantifying the effects of forest harvesting on floods in snow environments." *Water Resources Research*, *50*(3), 2769–2774.
7. Alila, Y., & Green, K. C. (2014b). Reply to comment by Bathurst on "A paradigm shift in understanding and quantifying the effects of forest harvesting on floods in snow environments." *Water Resources Research*, *50*(3), 2759–2764
8. Schnorbus, M., & Alila, Y. (2013). Peak flow regime changes following forest harvesting in a snow-dominated basin: Effects of harvest area, elevation, and channel connectivity. *Water Resources Research*, *49*(1), 517-535.
9. Yu, X. J., & Alila, Y. (2019). Nonstationary frequency pairing reveals a highly sensitive peak flow regime to harvesting across a wide range of return periods. *Forest Ecology and Management*, *444*, 187-206.
10. Rong W. N. & Alila Y. (2022), Effects of forest harvesting on large peak flows, Part 1 of Two Parts: Frequency pairing in rain-on-snow environment challenges a long-standing paradigm in Forest Hydrology (under review).
11. Alila Y. & Rong W. N. (2022), Effects of forest harvesting on large peak flows, Part 2 of Two Parts: Moving ahead with application of the frequency-pairing experimental design in Forest Hydrology (under review).

- All studies led to outcomes diametrically opposite to the prevalent CP-based wisdom:

1. Harvesting affects events of all sizes
2. Effects increase with event size
3. Most cases, there is no apparent threshold flood size beyond which harvesting has no effects.

Studies highlighted in **blue** applied CP and FP to the same data sets to illustrate how to the two frameworks do not lead to the same outcomes, especially on the effects on larger events.

Contents lists available at ScienceDirect

Forest Ecology and Management

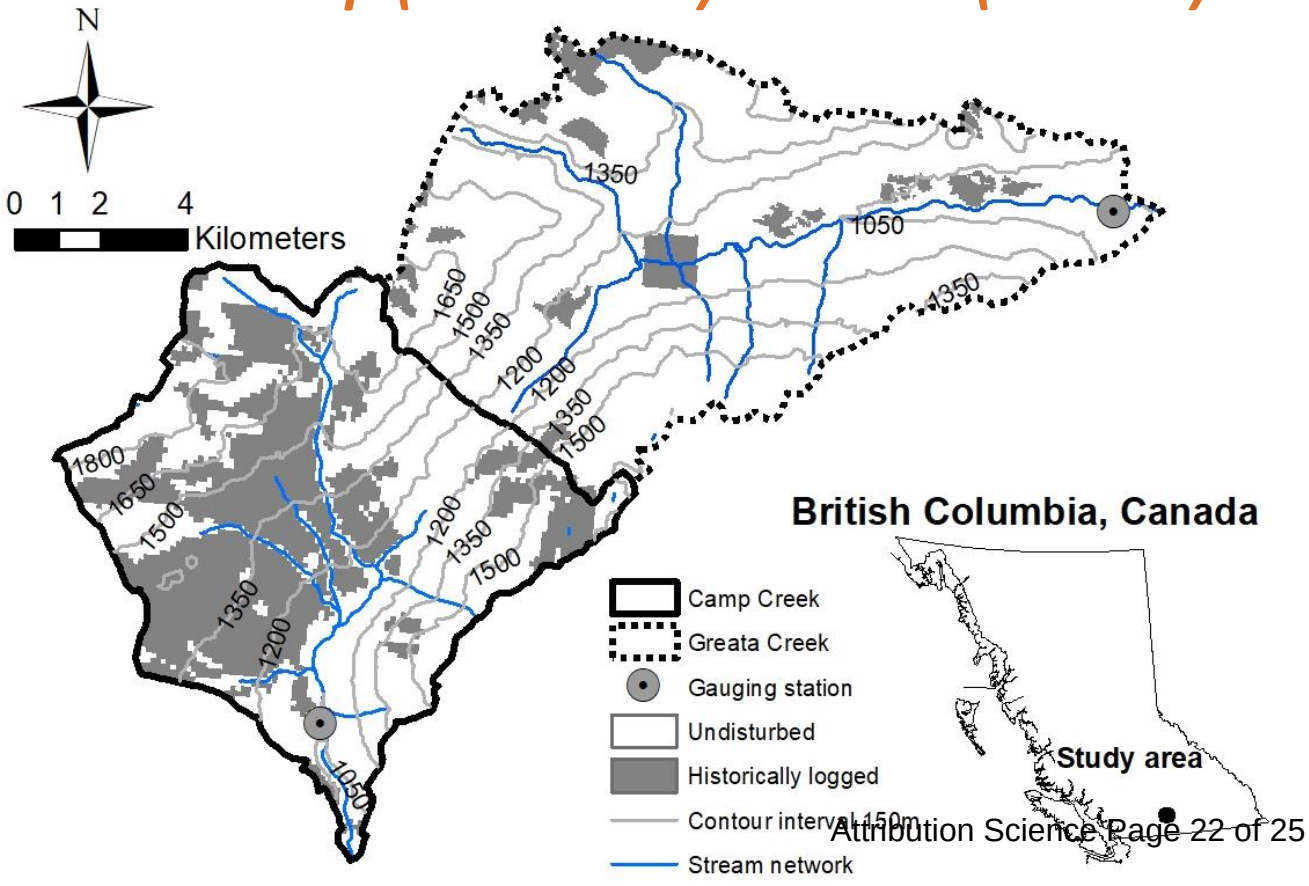
journal homepage: www.elsevier.com/locate/foreco

Nonstationary frequency pairing reveals a highly sensitive peak flow regime to harvesting across a wide range of return periods

XuJian Joe Yu*, Younes Alila

Forest Resources Management, Faculty of Forestry, University of British Columbia, Vancouver, Canada

FIRST PAIR: Camp (treatment) - Greata (control) Creeks



A New Nonstationary FP Design Protocol

Pioneering a paired watershed study approach where we pair by equal frequency in a non-stationary framework

Advantages of the stochastic non-stationary paired watershed study approach:

- Does not require the use of a calibration equation because of a new role of the control watershed
- Control and treatment watersheds do not have to be similar in physiography or meteorological input
- Not constraints to just small and in close proximity control and treatment watersheds
- Allows opportunistic studies to be conducted in a controlled setting outside of conventional experimental watersheds.

More Research is Needed Guided by the Following Hypotheses

- Forest disturbances affect not only small and medium events with return periods less than 10 years but even the larger, more extreme floods, namely events with 20-, 50-, and 100-year return periods and beyond.
- In most situations, a no-effect threshold return period beyond which disturbances do not have an effect on floods is nonexistent, and the larger the flood event the greater the effects on such a flood event.
- Floods in larger watersheds may be affected by disturbances more so than their smaller headwater tributaries.
- Depending on watershed physiographic characteristics, extreme events such as the 50- and 100-year floods can become many times more frequent as a result of some disturbances.
- Flood regimes can be sensitive to even small disturbances when occurring in critical mid-to-hight elevation zones within mountainous, high-elevation-range watersheds.

More Research is Needed Guided by the Following Hypotheses

- Watersheds with flatter topographies are even more sensitive to forest disturbances than areas on sloped topographies due to synchronization of snowmelt, regardless of disturbance location or watershed size.
- In some cases, a small forest disturbance or cut rate within a watershed could wrongly lead to an expectation of less impact because the sensitivity of the flood regime is controlled not only by how much is being logged but by what is left behind after disturbance.
- Logging practices other than clear-cutting may still take advantage of the natural ability of the forest cover to mitigate against flood risk, especially so under a changing climate.
- The effects of forest disturbances could be long-lasting despite replanting because the regrowth of coniferous trees in snow environment, is chronically slow. Full hydrologic recovery of the new forests to pre-disturbance conditions usually takes over 80 years.

Thank you

GEOMORPHIC RESPONSES TO WILDFIRE (PRESENTATION 2)

Geomorphic Response to Wildfire in British Columbia

Tim Giles, P.Geo.
Westrek Geotechnical Services

1

Outline

- History of Post-Wildfire Natural Hazards in BC
- Burn Severity Maps
- Wildfire effects
  - Soil
  - Hydrology
  - Geomorphology
- Post-Wildfire Assessments
- Publications and People
- Weather and Climate
- Recovery

2

History of Post-Wildfire Natural Hazards in British Columbia

- 1998 - Silver Creek Fire
- 2003 - McLure, Okanagan Mountain, Cedar Hills
- 2007 - Nelson
- 2009 - McLean, Seton Portage, Notch Hill
- 2010 - Cariboo
- 2014 - Northern BC
- 2015 - Coast, Kamloops + Nelson
- 2017 - Elephant Hill, Hanceville, Plateau
- 2018 - All of BC
- 2021 - All of BC

3

Big Stick 2021

McAllister 2014

Hanceville 2017

Plateau 2017

Elaho 2015

Mount Hunter 2021

4

Criss Creek 2021

Momich 2021

Snohoosh Lake 2021

Whiteman Creek 2021

Deadman 2021

Nk'Mip 2021

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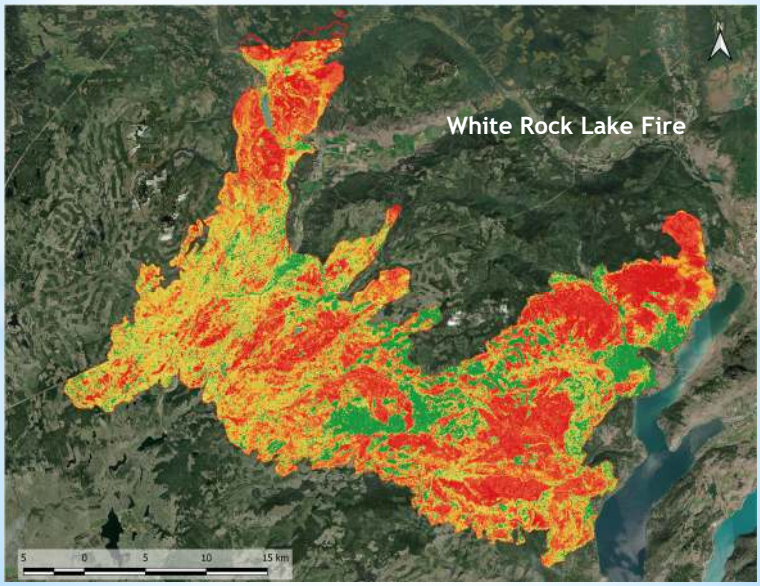
5

Burn Severity Maps



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Burn Severity Maps

Satellite imagery

Estimate the change to the vegetation coverage by comparing spectral indices from pre- and post-fire images that are sensitive to changes caused by fire.

- **Vegetation burn severity**

  Compares the visual difference between two images.

- **Soil burn severity**

  Field testing, LFH removal, thickness of remaining soil, depth to live roots, water repellent layer, coarse fragments, ash, vegetation regrowth, consumption of downed woody debris, needles



7

Wildfire Effects

- **Soil**
  - LFH - litter, fermented/fibric, humus
    - Porous, protect surface soil, prevent erosion
  - BC interior generally has a thin LFH
    - IDF < 5 cm
    - MS, SBPS, SBS, ESSF 5-10 cm
    - ICH thicker
    - Grassland soils
  - Organic LFH burns readily
    - Alters soil structure
    - Reduces organic matter (binding)
    - Increases erodibility
    - Vaporize organics substances - water repellency



8

Unburned LFH in MS

High Burn Severity

Moderate Burn Severity

High Burn Severity

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Burned Soil

- Exposed mineral soil and more precipitation (snowmelt) reaches soil
- Soil has reduced structure and cohesion
- Lower infiltration capacity
- Higher erodibility
- Water repellent

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Wildfire Effects

- **Hydrology**
  - Increased and flashier overland flow
  - Sediment-laden water more erosive
  - More water moved more quickly

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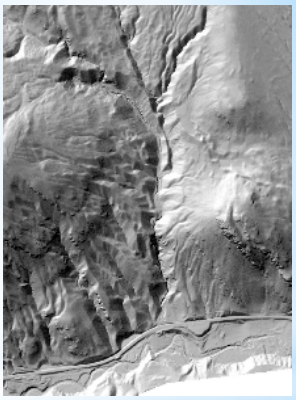
Hydrology

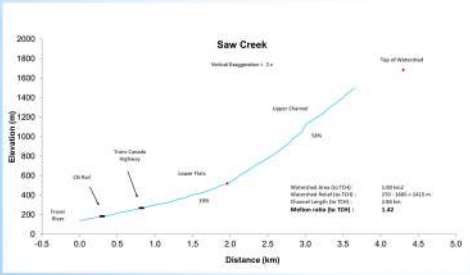
- **Snowmelt freshet floods**
  - Watershed scale, slower rise
- **Intense rainstorm events**
  - Instantaneous response, flashy

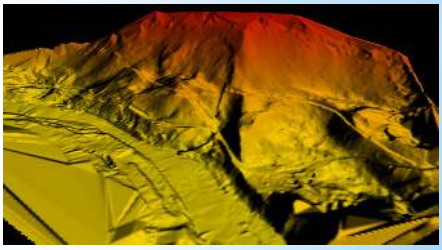
12

Wildfire Effects

- **Geomorphology**
  - Topographic maps
  - Surficial geology maps
  - Bedrock geology maps
  - Lidar
  - Physiographic characteristics
    - Longitudinal profiles
    - Melton ratio, relief index







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Geomorphology

- **Hydrogeomorphic processes**
  Flood, sediment-laden flood, debris flood, debris flow, landslide, rock fall
- **Elements at Risk**
  Location, location, location

Seton Portage

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Geomorphology

- **Observation of landform features that are indicative of previous landslides.**

  Commonly on alluvial fans at the outlet of creeks

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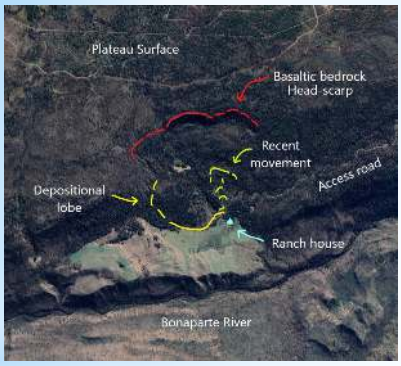
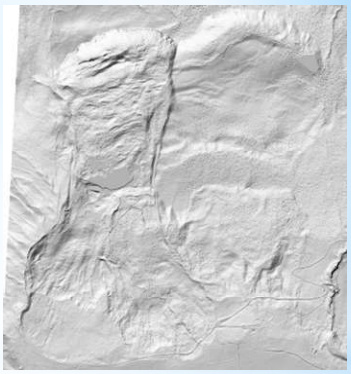
15



Horse Camp Ranch



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Post-Wildfire Natural Hazards Risk Analysis

Completed following a wildfire to quantify the downslope and downstream risks to life, property, and infrastructure, or "elements at risk."

Reconnaissance Assessment

Collect information for a preliminary analysis of post-wildfire conditions.

- identifies the elements at risk,
- characterizes the possible natural hazards, and
- estimates the partial risk to identified elements.

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Post-Wildfire Natural Hazards Risk Analysis

Detailed Assessment

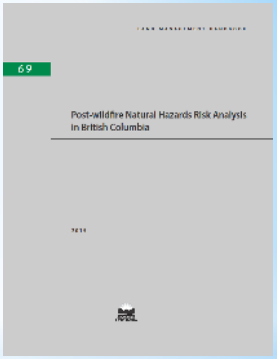
Requires consideration of the burn severity and post-wildfire soil, hydrologic, and slope stability conditions.

- elaborates on the hazards and risks identified in the reconnaissance report,
- identifies the need for risk mitigation, and
- provides conceptual designs for the mitigation measures.

18

Post-Wildfire Natural Hazards Risk Analysis, 2015

- **FLNRO Land Management Handbook 69**
  - Compilation of BC post-wildfire knowledge to 2015



Large-scale Erosion and Flooding after Wildfires, 2006

- **FLNRO Technical Report 030**
  - Understanding the Soil Conditions

Water Repellent Soils: a state-of-the-art, 1981

- **USDA General Technical Report PSW-46**
  - Leonard DeBano

Effect of Wildfire on Soil Wettability in the High Cascades of Oregon, 1976

- **USDA Forest Service Research Paper PNW-202**
  - Christen Dyrness

USDA – Robichaud, Elliot, Neary

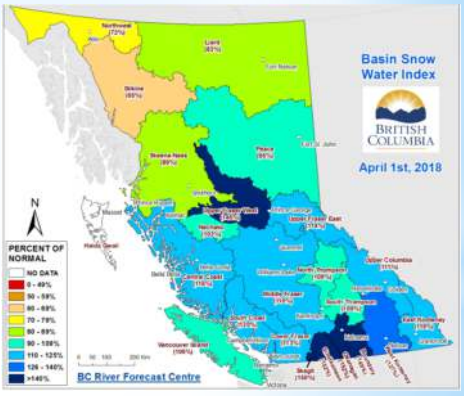
USGS – Cannon, Gartner, Santi, Prochaska, Rengers, Kean

19

Weather and Climate

- **Snowmelt freshet floods**
  - Watershed scale
  - Snowpack accumulation
  - Snowmelt timing
  - Rain on snow

  Coordination of climate factors

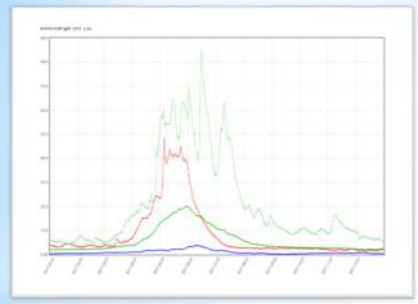


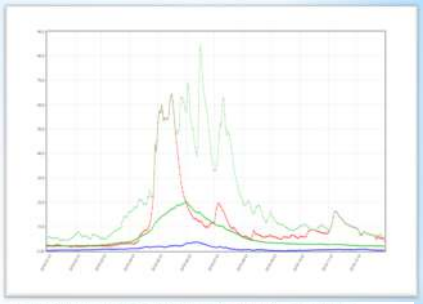
- **Intense rainstorm events**
  - High intensity rain
    - 10 mm per hour
    - 20 mm per day
  - Thunderstorms, not entirely unpredictable

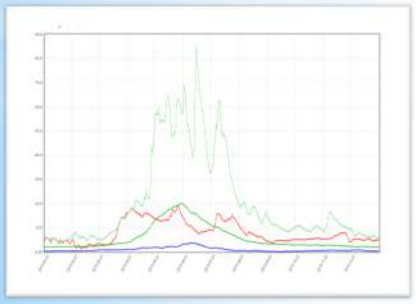
- **Long-term rainfall**

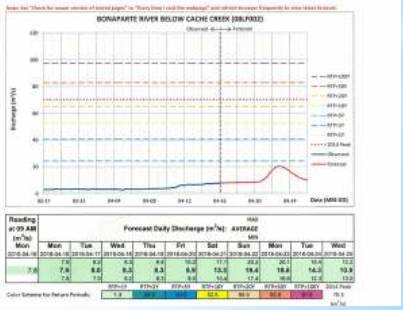
20

Bonaparte River @ Cache Creek









21

Recovery

- **Time**
  - Effects of wildfire can last a long time, standing dead trees, minimal undergrowth, lack of surface soil, runoff, sedimentation increases
  - Water repellency is common for 1-3 years, but there is usually natural water repellency in soils
  - Soil regeneration: it takes time to accumulate and decay grasses, mosses and shrubs; may appear healed but the LFH layer is very thin for years
  - Aspect, biogeoclimatic zone, salvage harvesting

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Thank you

Tim Giles PGeo
Geoscientist, Westrek Geotechnical Services

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WILDFIRE AS AN AQUATIC HABITAT RESET (PRESENTATION 3)

Wildfire: hitting the aquatic habitat reset button?

Rebecca Flitcroft, Gordon Reeves

United States Forest Service
Pacific Northwest Research Station
Rebecca.Flitcroft@usda.gov

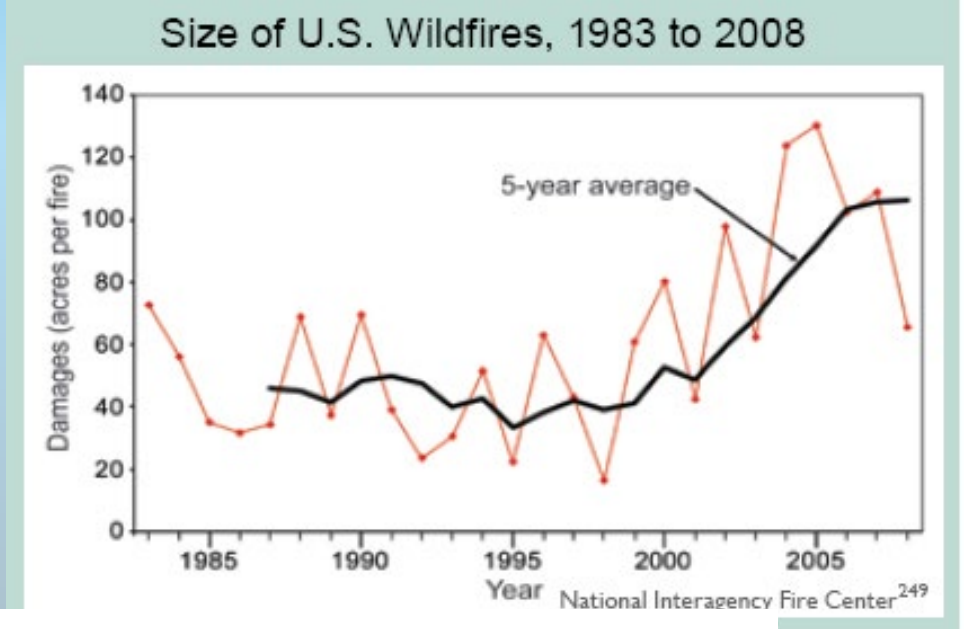
Fire is a significant disturbance at landscape scales.

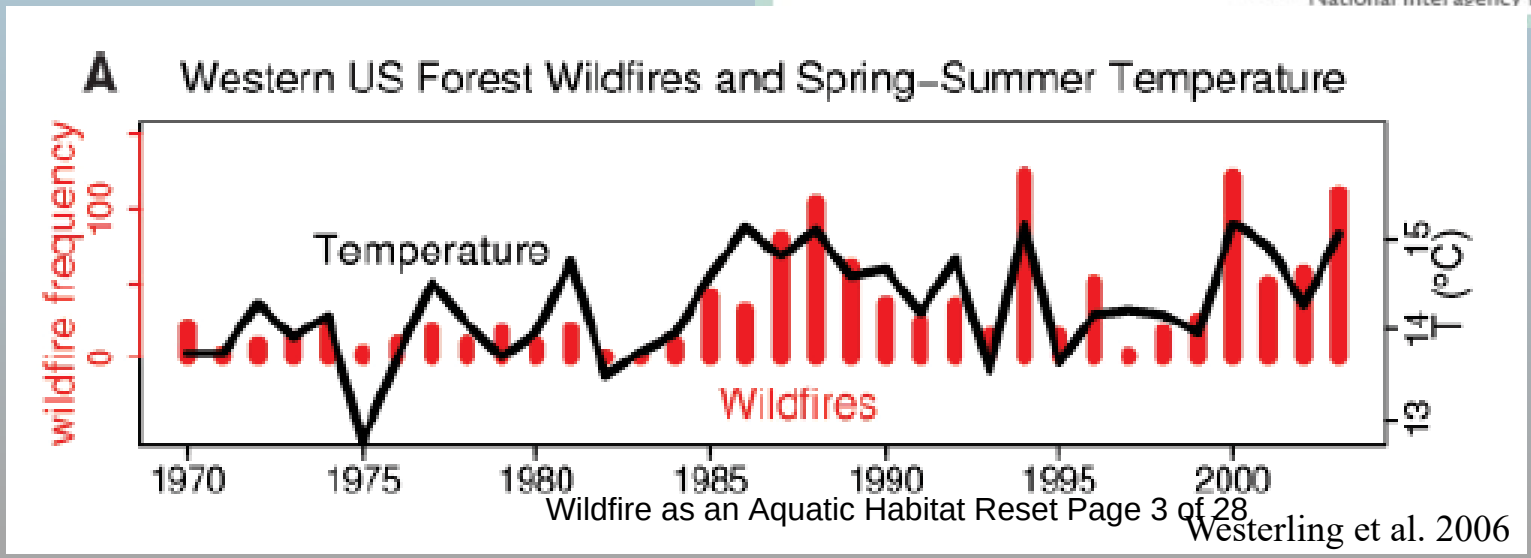
Source: https://fires.globalforestwatch.org

Fire size and recurrence interval have changed over time

Since 1980's

- Higher frequency
- Larger
- Longer season





Westerling et al. 2006

How did we get here?

Native people set fires to reduce fire severity, and enhance forage for ungulates and food plants.

Wildfire suppression

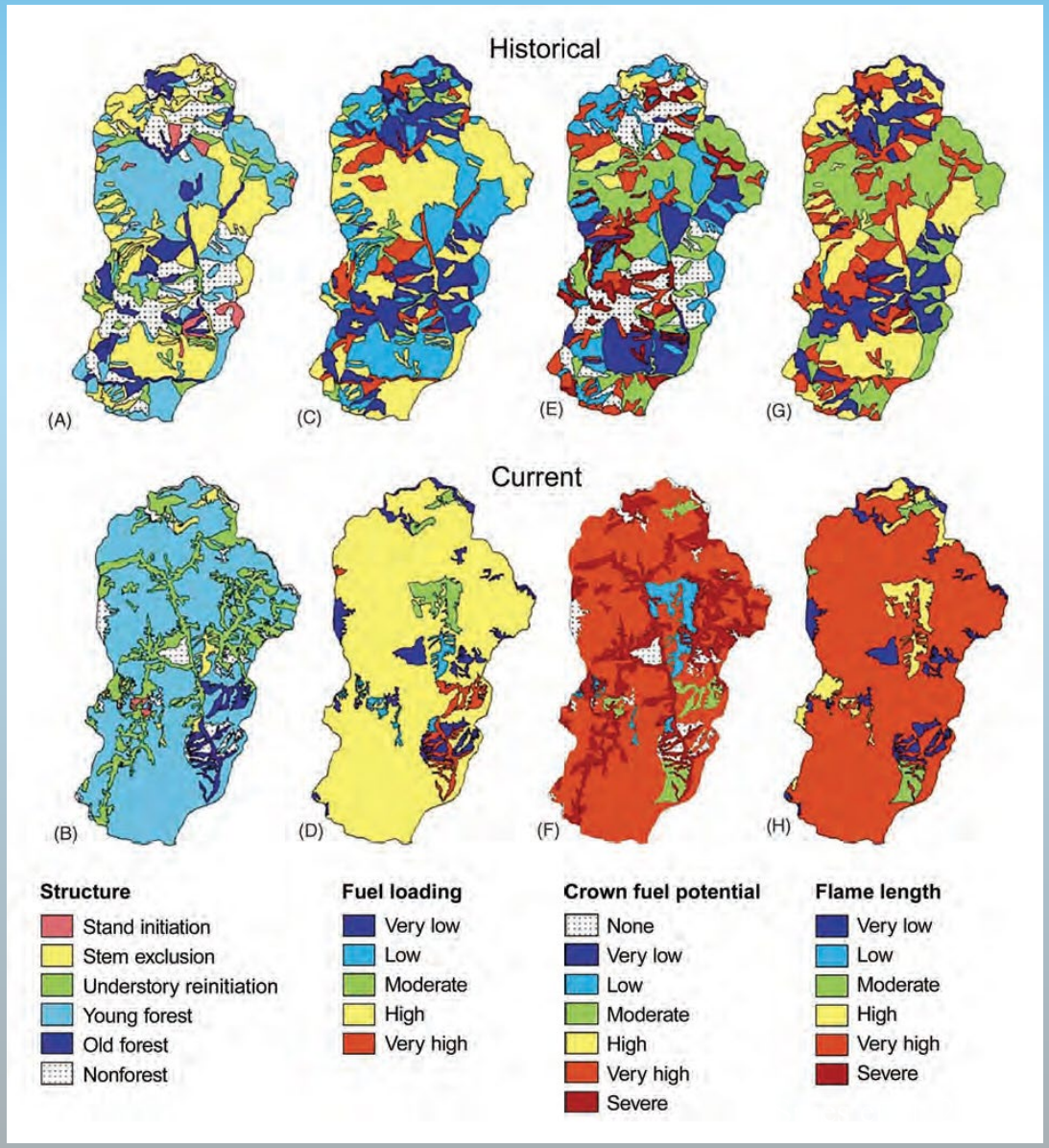
Removal of largest trees when logging. These were the most fire resistant trees with the deepest bark.

More trees growing on the landscape

Lack of landscape mosaic that creates natural fire breaks.

Climate change.

Spies et al. 2018



Loss of the complex matrix of forest stand ages and conditions leads to increased wildfire spread and intensity

Wildfire suppression combined with timber harvest methods can exacerbate fuel loads leading to high intensity fire events and fire propagation across the landscape.

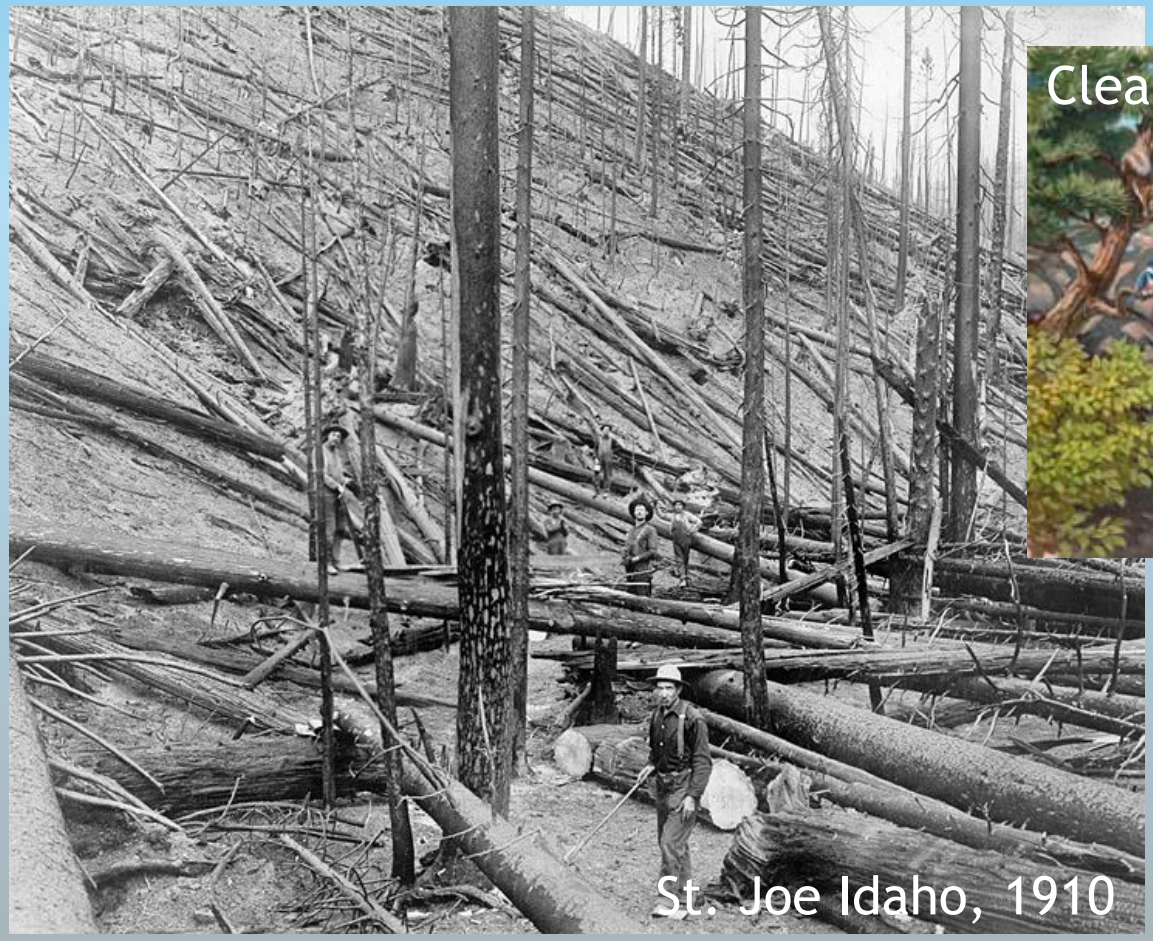
Traditional Perspective

"Forest fires catch fish, too.

Fish die *after* forest fires. Because the fire destroys the ground cover, and the streams and rivers get filled with suffocating silt."

Fire continues to be seen in the media and broader culture as only a negative effect on the landscape that should be managed. This perspective is extended to riparian areas and concerns regarding aquatic habitat quality.

The "Great Fires of 1910"


St. Joe Idaho, 1910

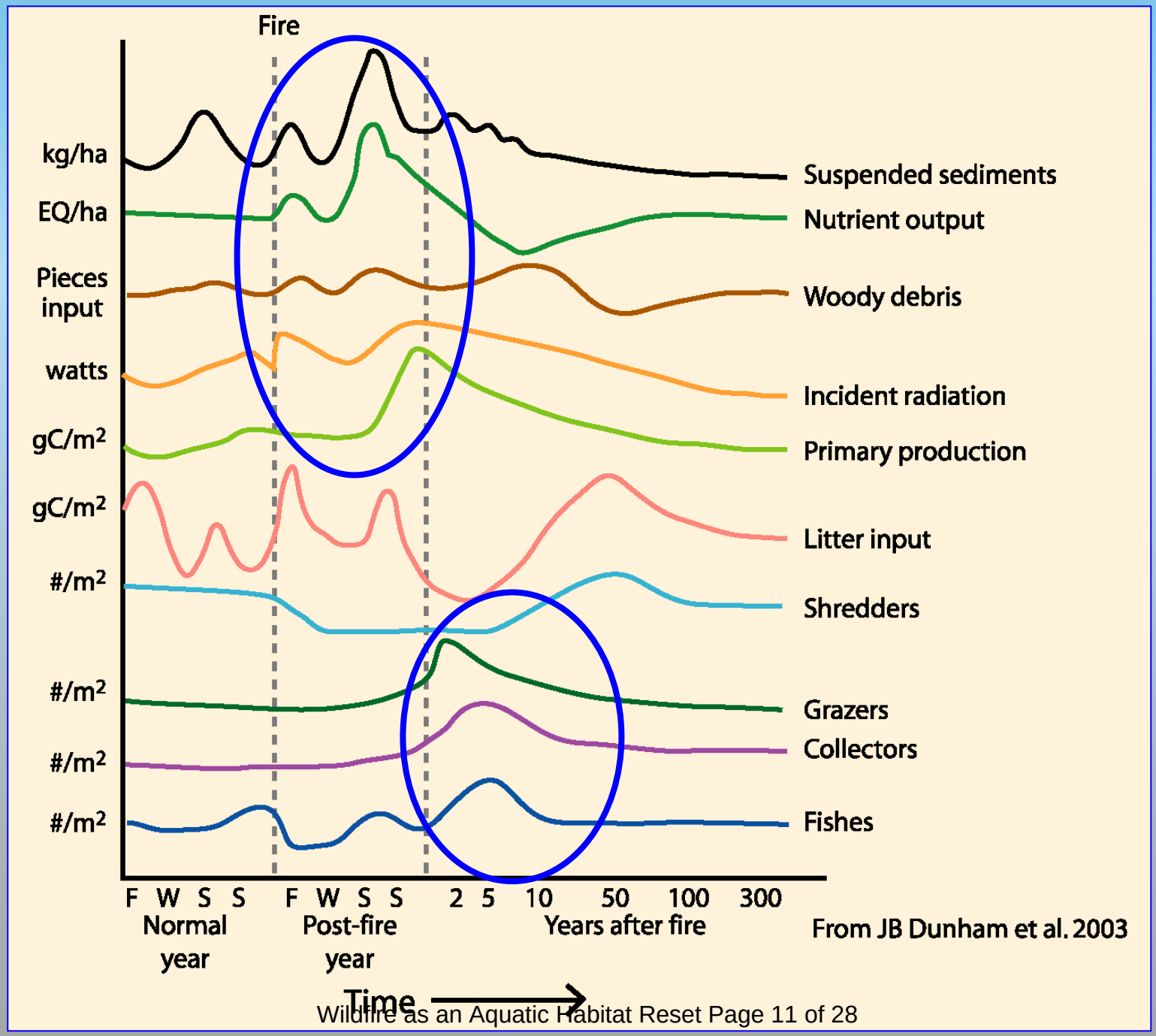
Arguments against fighting of fires went up in smoke with the Great Fires of 1910. Approximately 3 million acres of forest burned in NE Washington, N Idaho (the panhandle) and W Montana. The fires killed 87 people including 78 firefighters.

What are the relationships among wildfire, riparian areas, native fishes, and aquatic habitat over time?

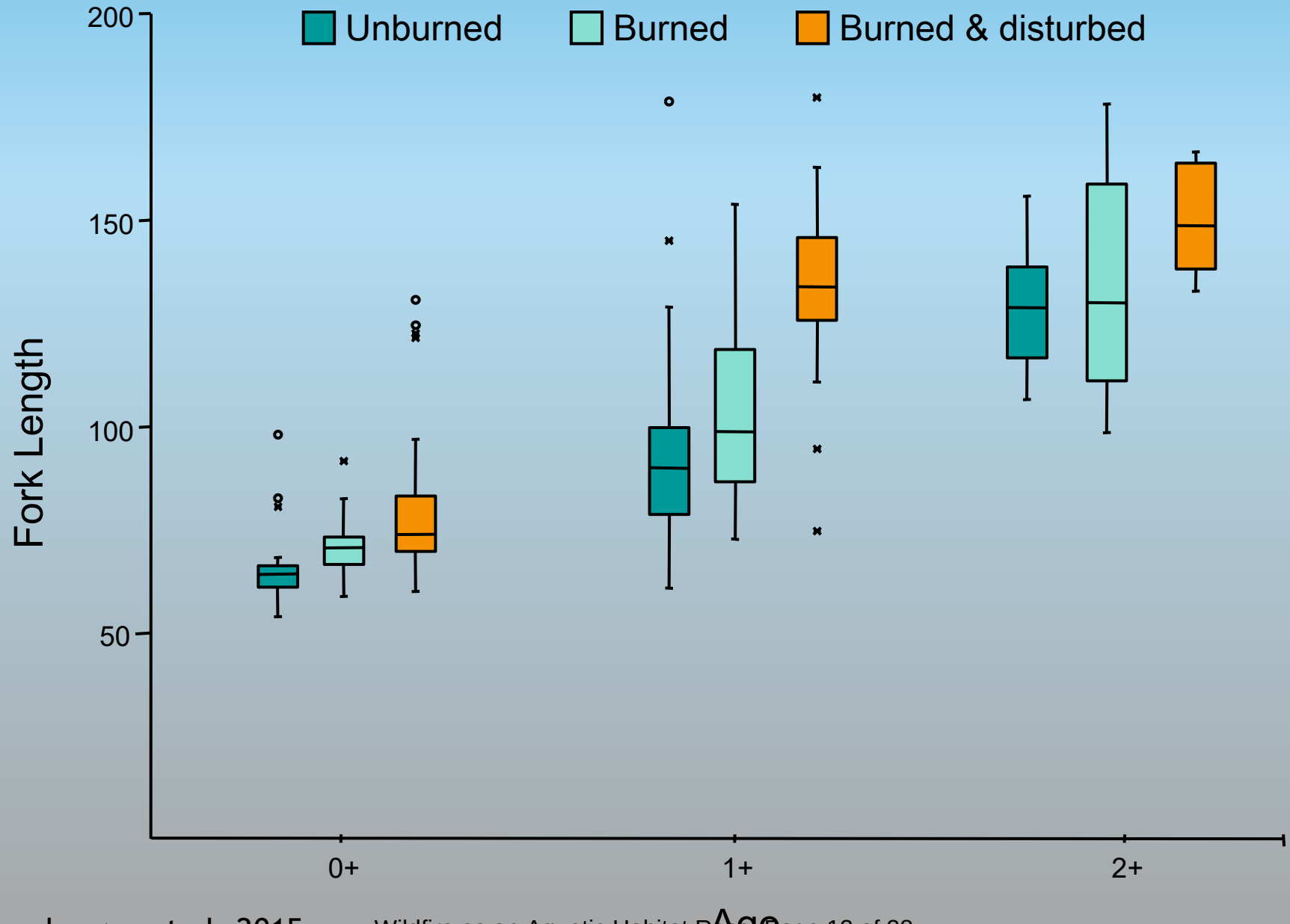
Emerging research that is often opportunistic in nature, has begun to paint a complex picture of the effects of wildfire on riparian areas, native fishes and aquatic habitats.

Alternative View

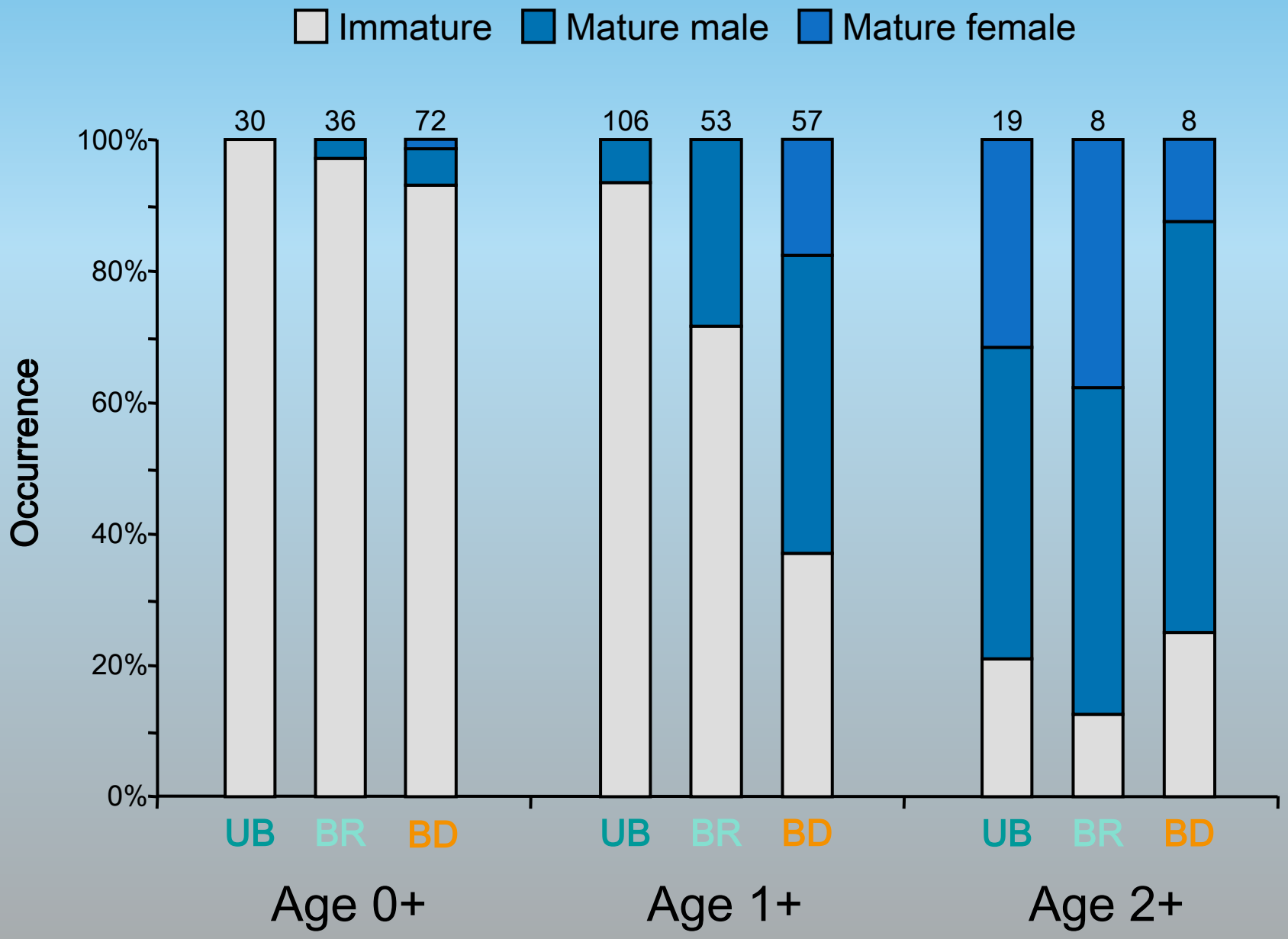
- Wildfire is a natural process
- Fish populations have persisted for millennia in fire- and disturbance-prone landscapes


Fire
kg/ha
EQ/ha
Pieces input
watts
gC/m²
gC/m²
#/m²
#/m²
#/m²
#/m²
Suspended sediments
Nutrient output
Woody debris
Incident radiation
Primary production
Litter input
Shredders
Grazers
Collectors
Fishes
F W S S F W S S 2 5 10 50 100 300
Normal year
Post-fire year
Years after fire
Time
From JB Dunham et al. 2003

Length at age



Rosenberger et al. 2015



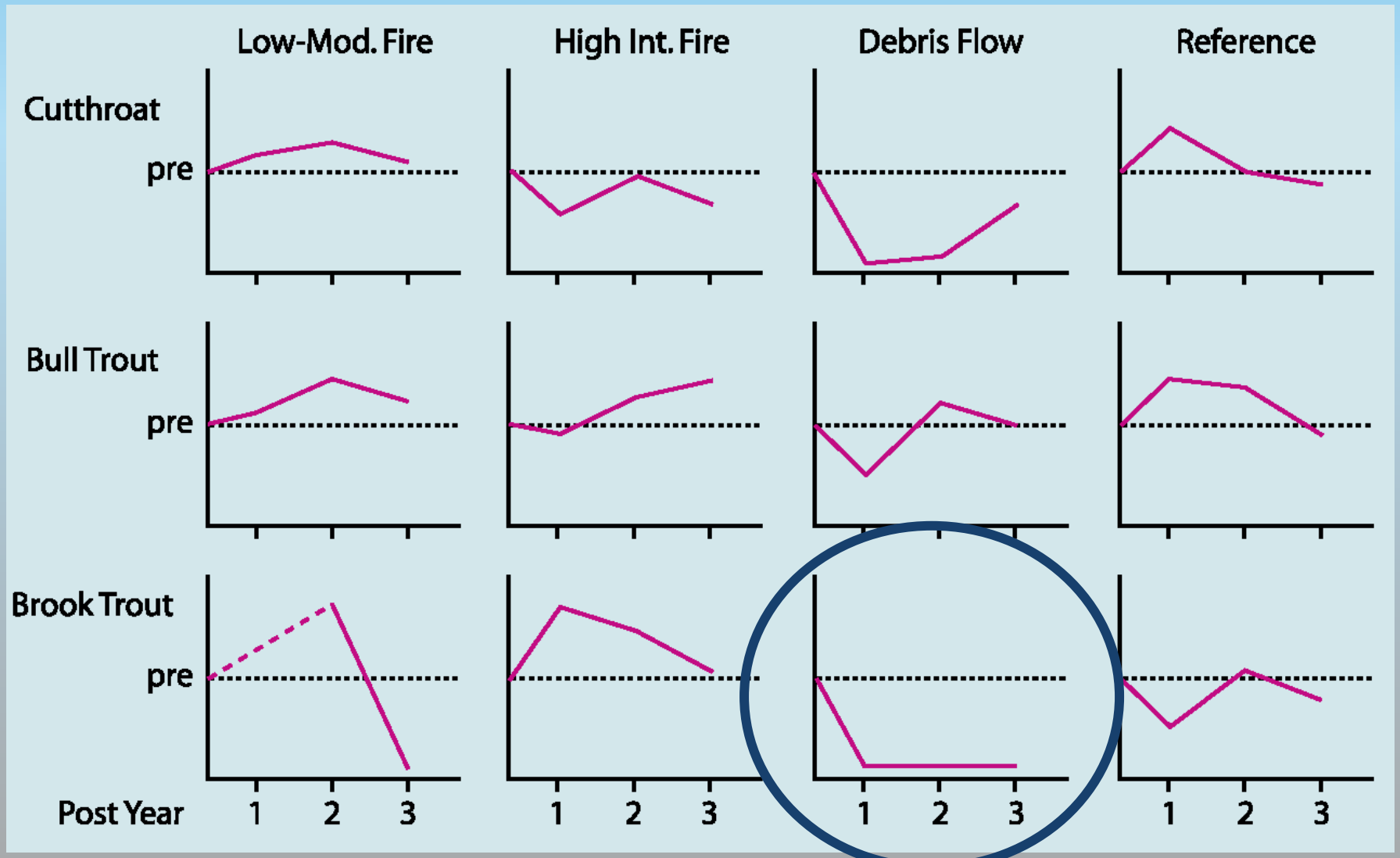
Rosenberger et al. 2015


Steelhead
© Morgan Bond

?

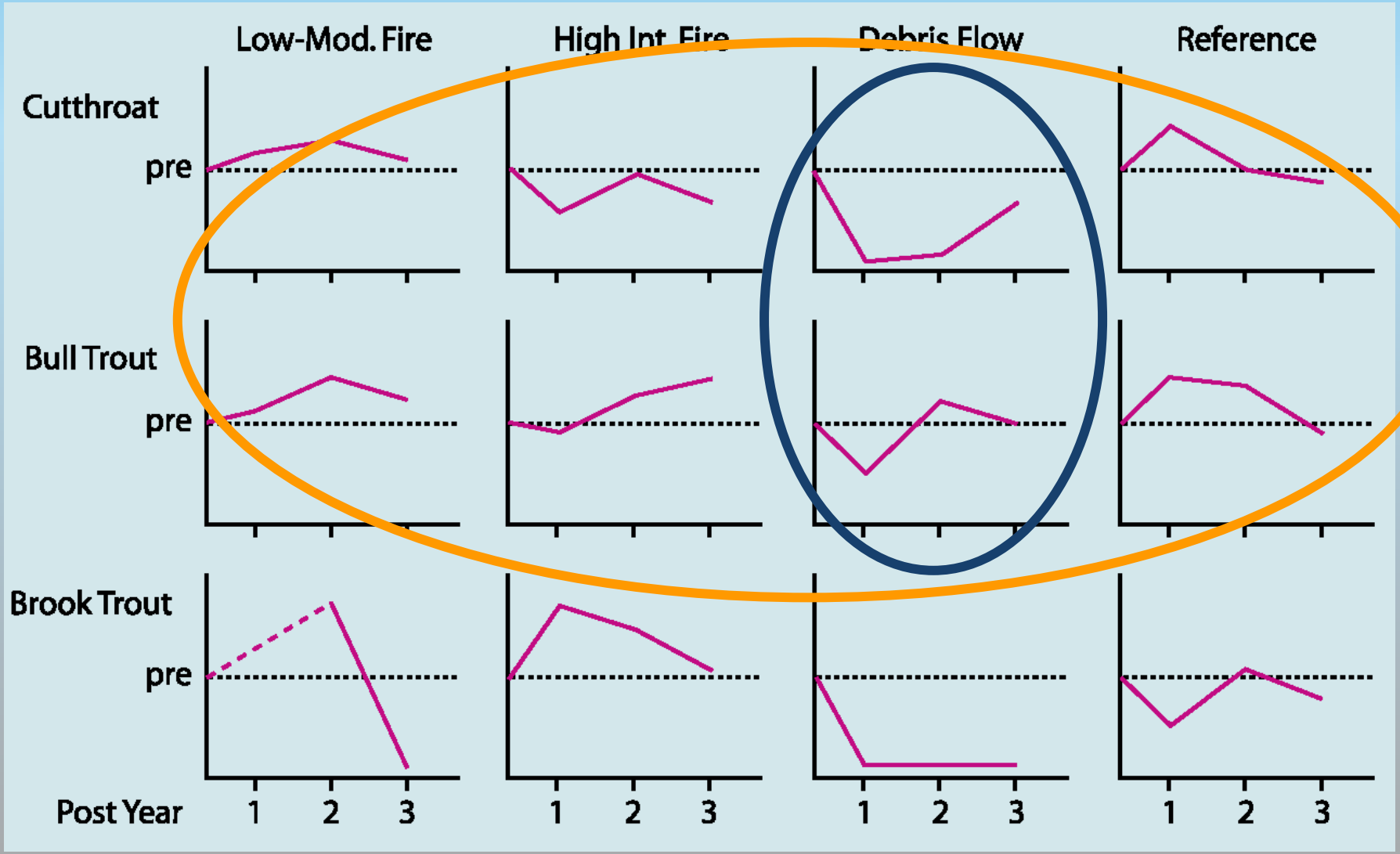

Rainbow Trout

Percent Change in Species Abundance



From: Sestrich et al. 2011

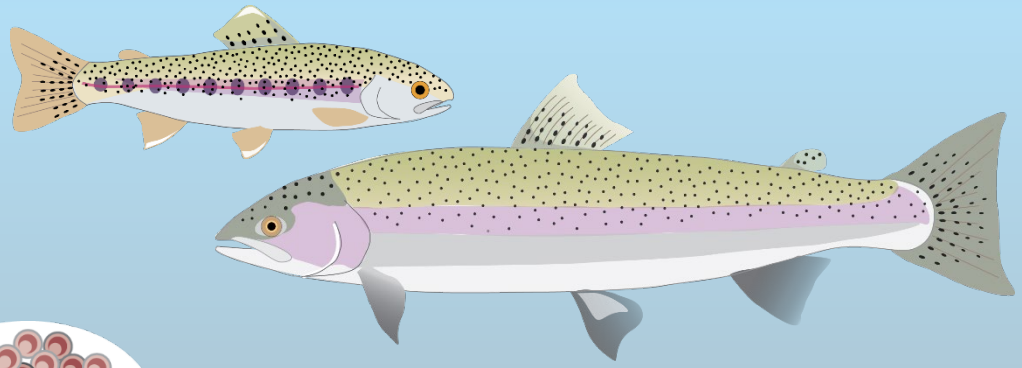
Percent Change in Species Abundance

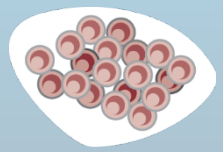


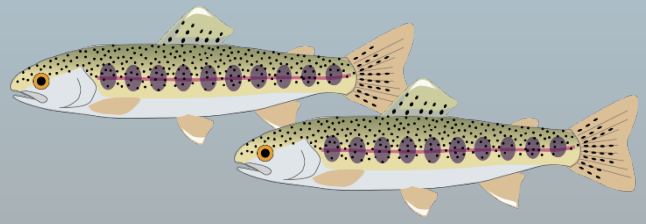
From: Sestrich et al. 2011

Adaptations of Anadromous Salmonids to Dynamic Environments

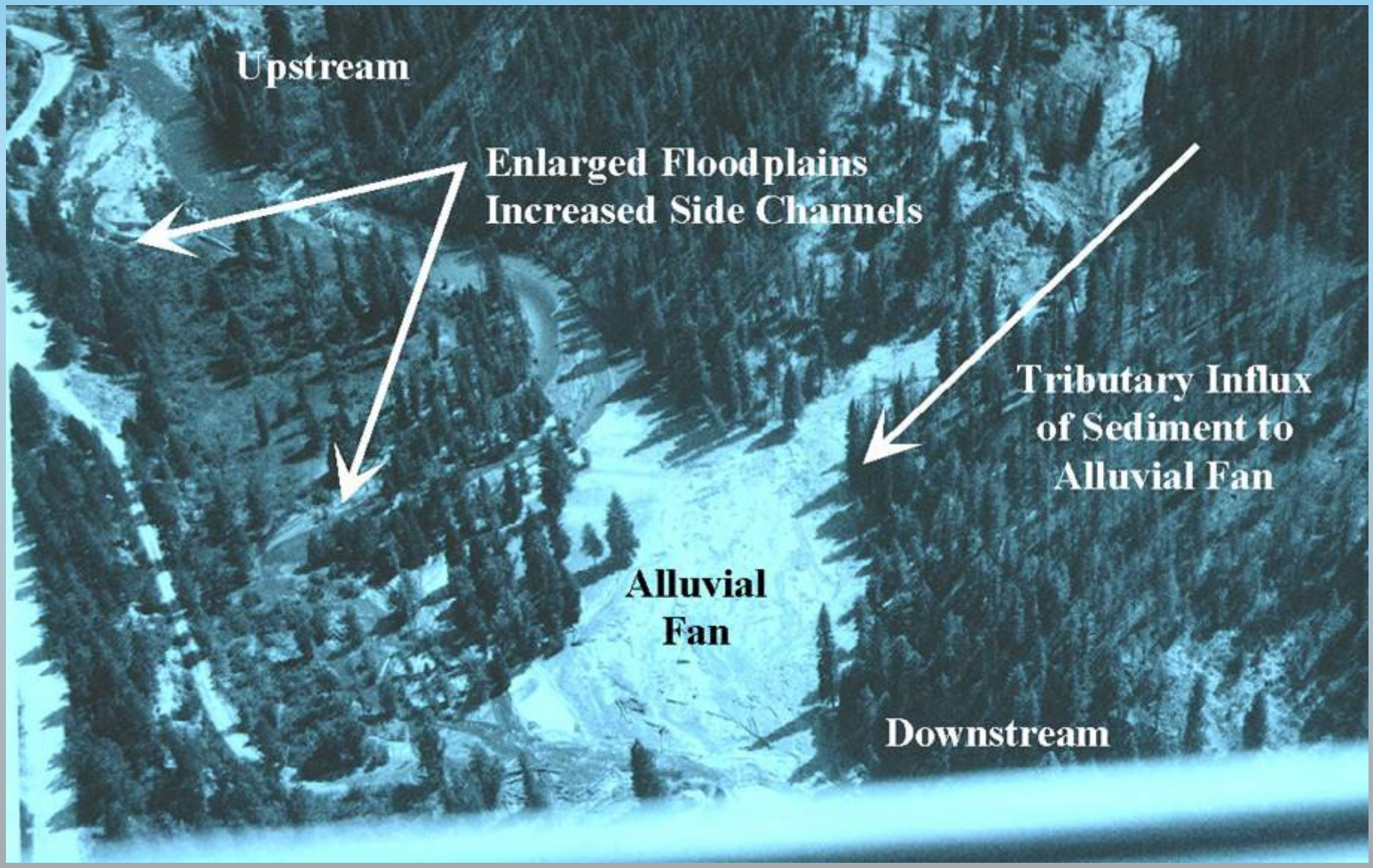
- Genetic flexibility
- Straying of adults
- High fecundity
- Mobility of juveniles



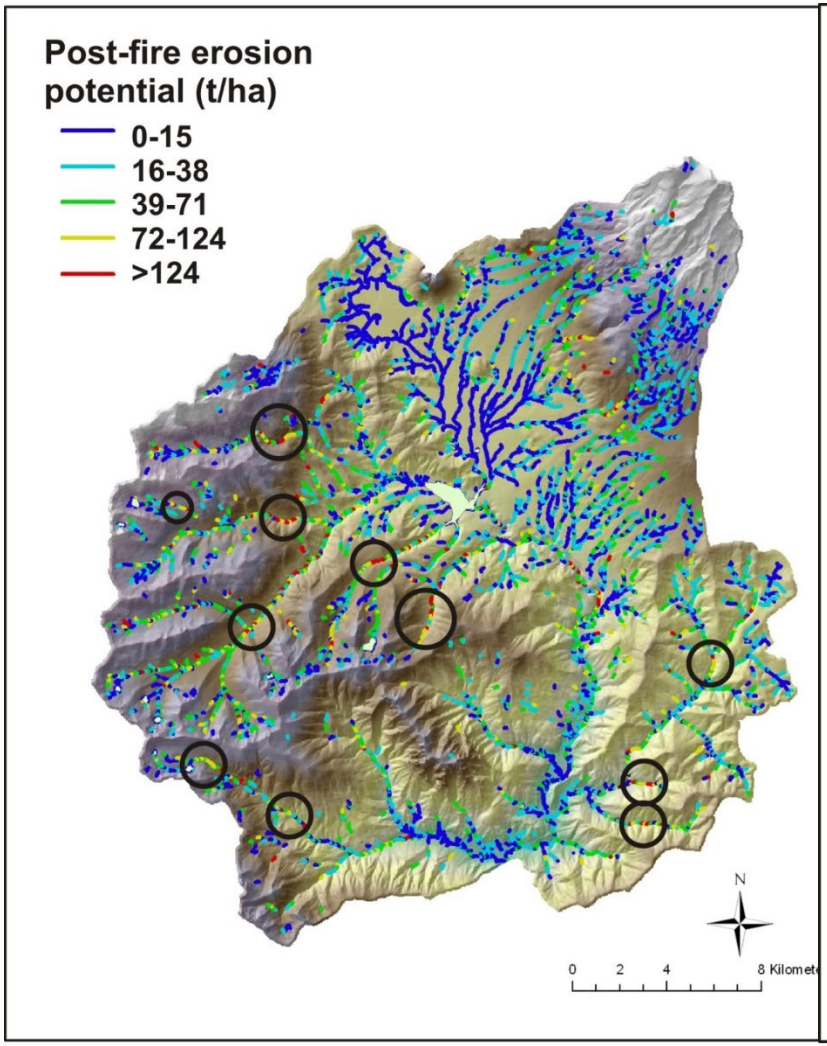


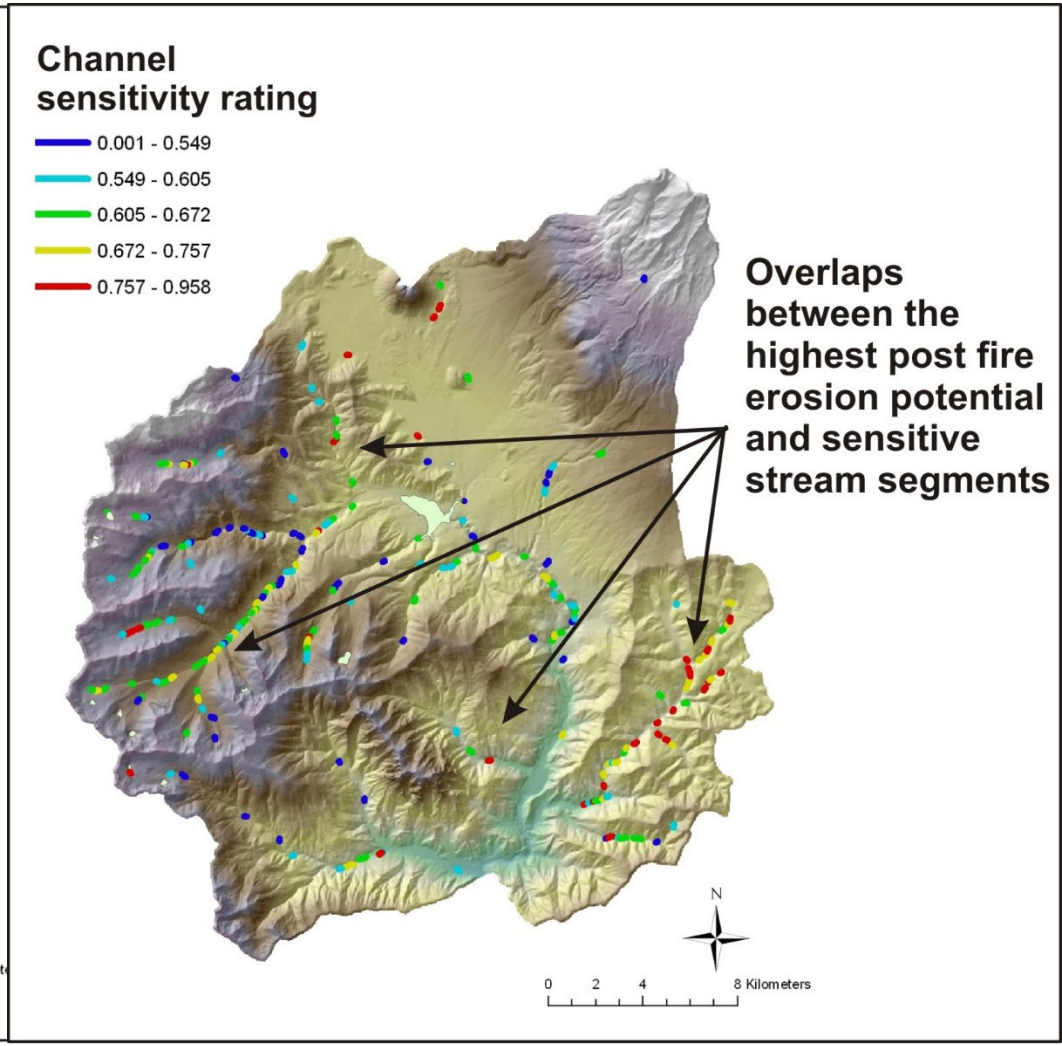


Boise Fire, Idaho

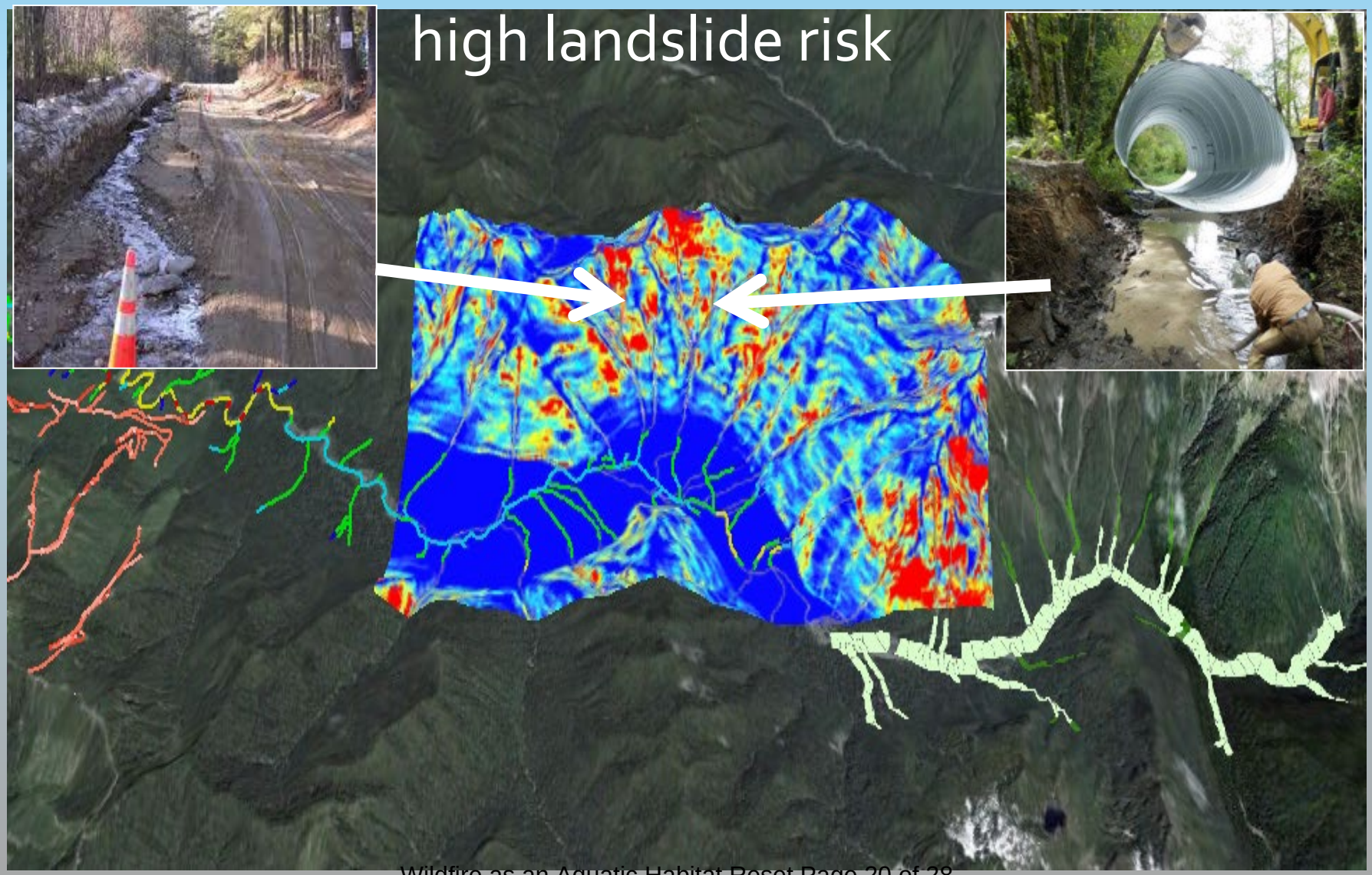


from: L. Benda


Post-fire erosion potential (t/ha)
0-15
16-38
39-71
72-124
>124
N
0 2 4 8 Kilometers

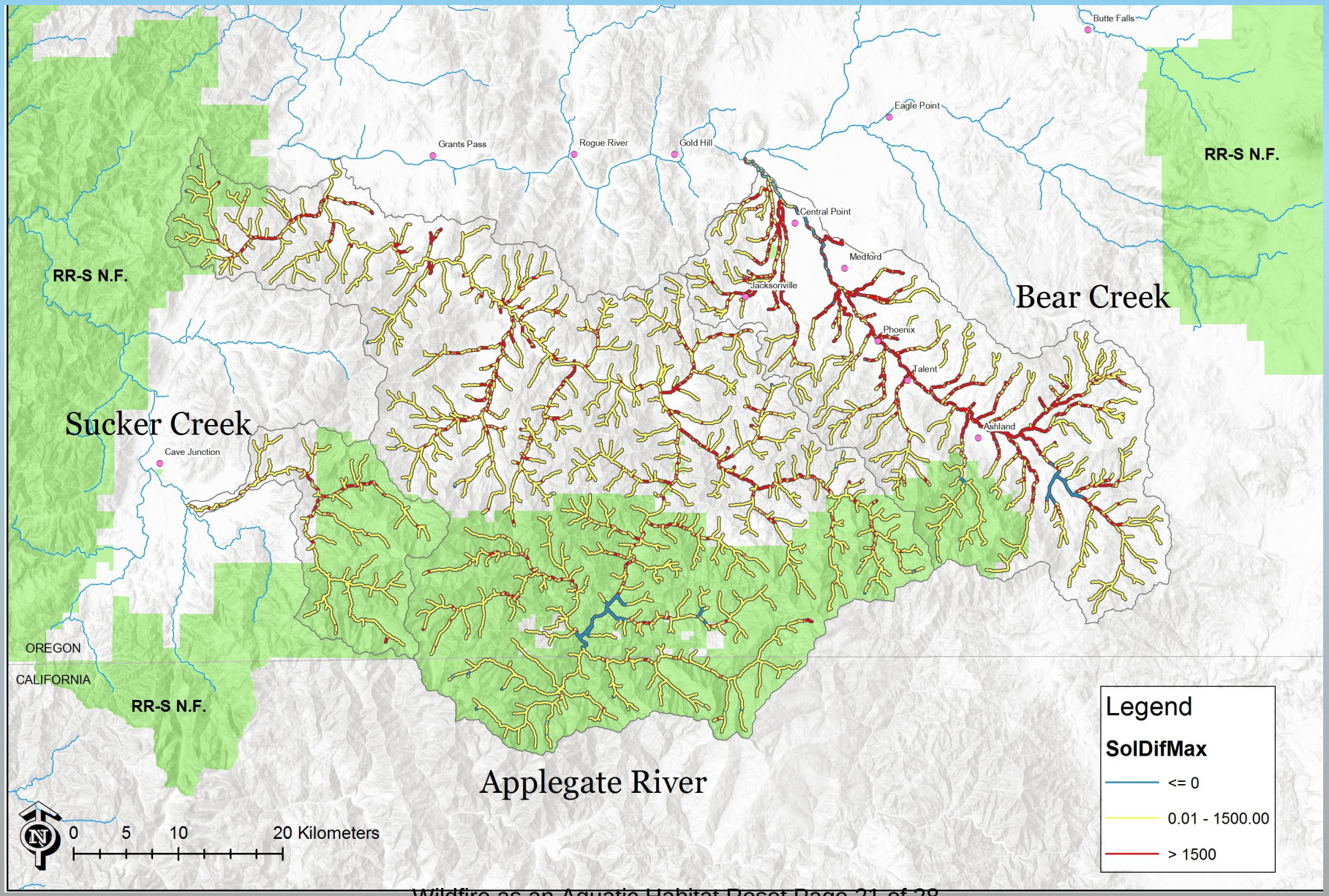

Channel sensitivity rating
0.001 - 0.549
0.549 - 0.605
0.605 - 0.672
0.672 - 0.757
0.757 - 0.958
Overlaps between the highest post fire erosion potential and sensitive stream segments
N
0 2 4 8 Kilometers

Priority Areas for Road Decommissioning & Culvert Replacement

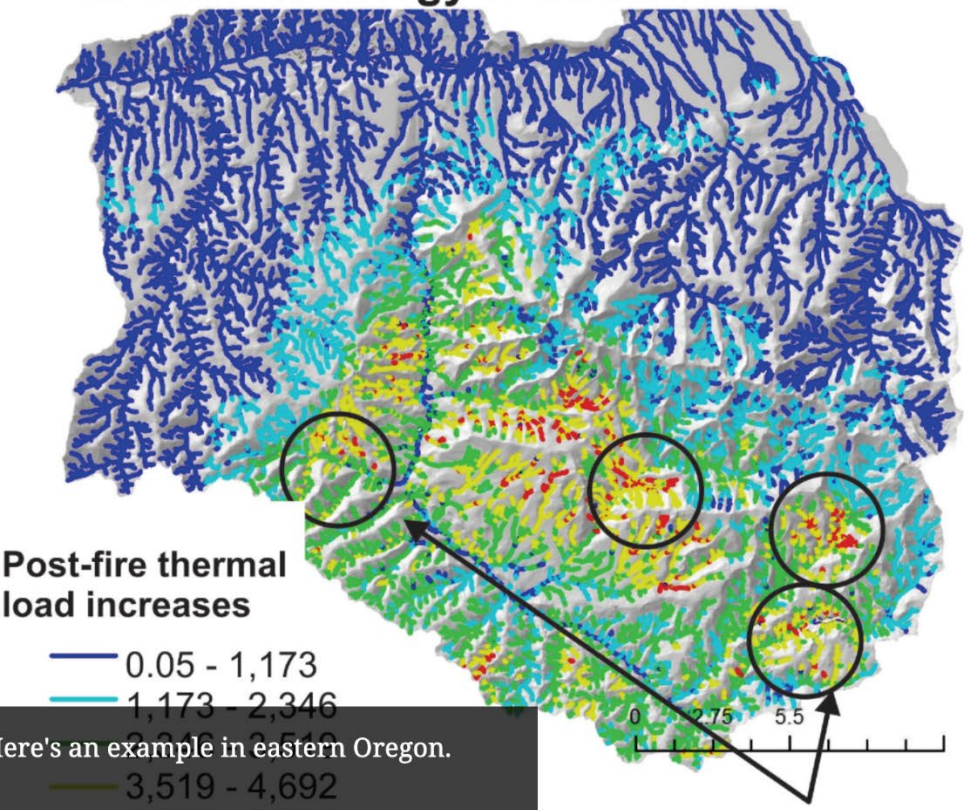


From: TerrainWorks (www.terrainworks.com)

Priority Riparian Areas for Water Temperature

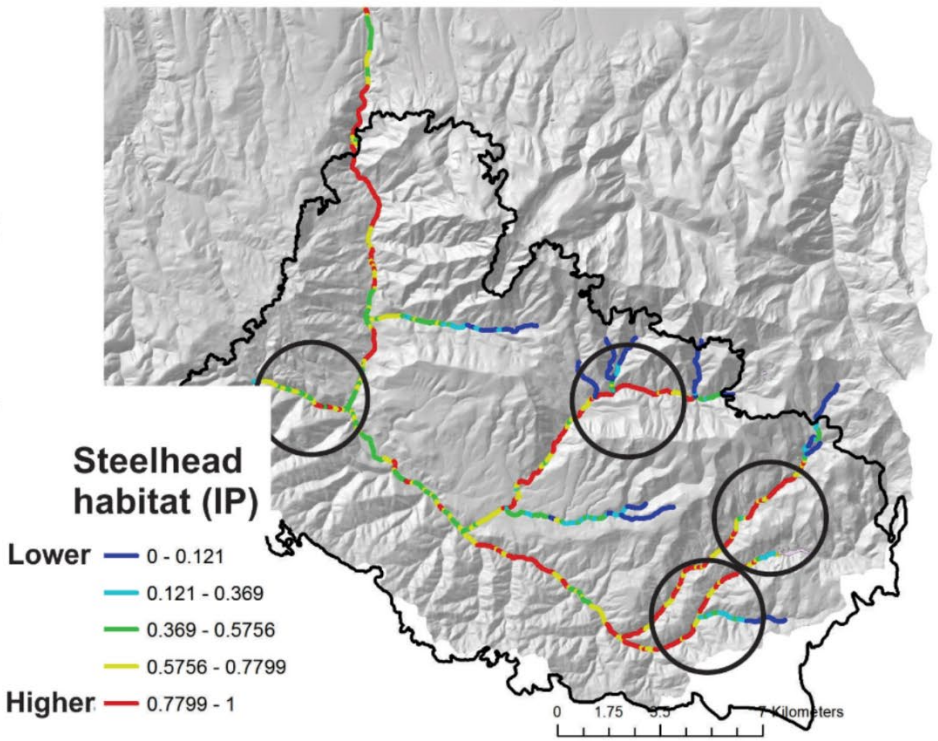


Post fire loss of shade and increases in thermal energy to streams



Here's an example in eastern Oregon.

Steelhead habitat (IP)



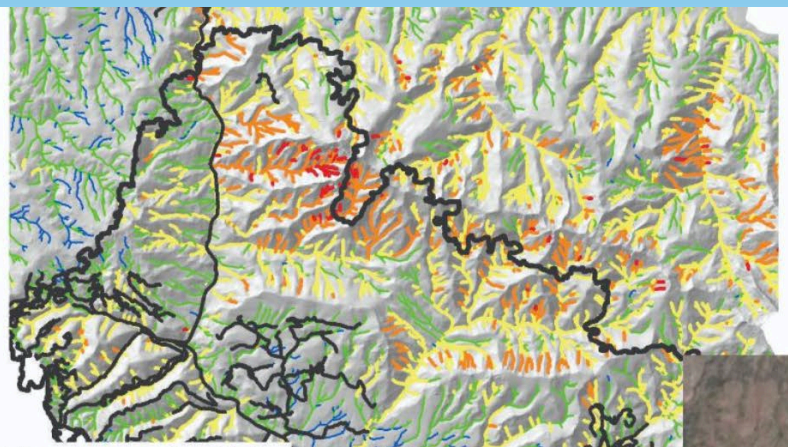
Largest decreases in post fire shade and increases in thermal energy, overlapping with best steelhead habitat

Implications

- Is wildfire a threat?
  - Other human influences probably more of a threat
  - Climate change may override everything

Implications

- Is wildfire a threat?
  - Other human influences probably more of a threat
  - Climate change may override everything
- Post-fire Activities
  - Generally will not require intervention
  - May be places in watershed where reduce potential risk of adverse effects

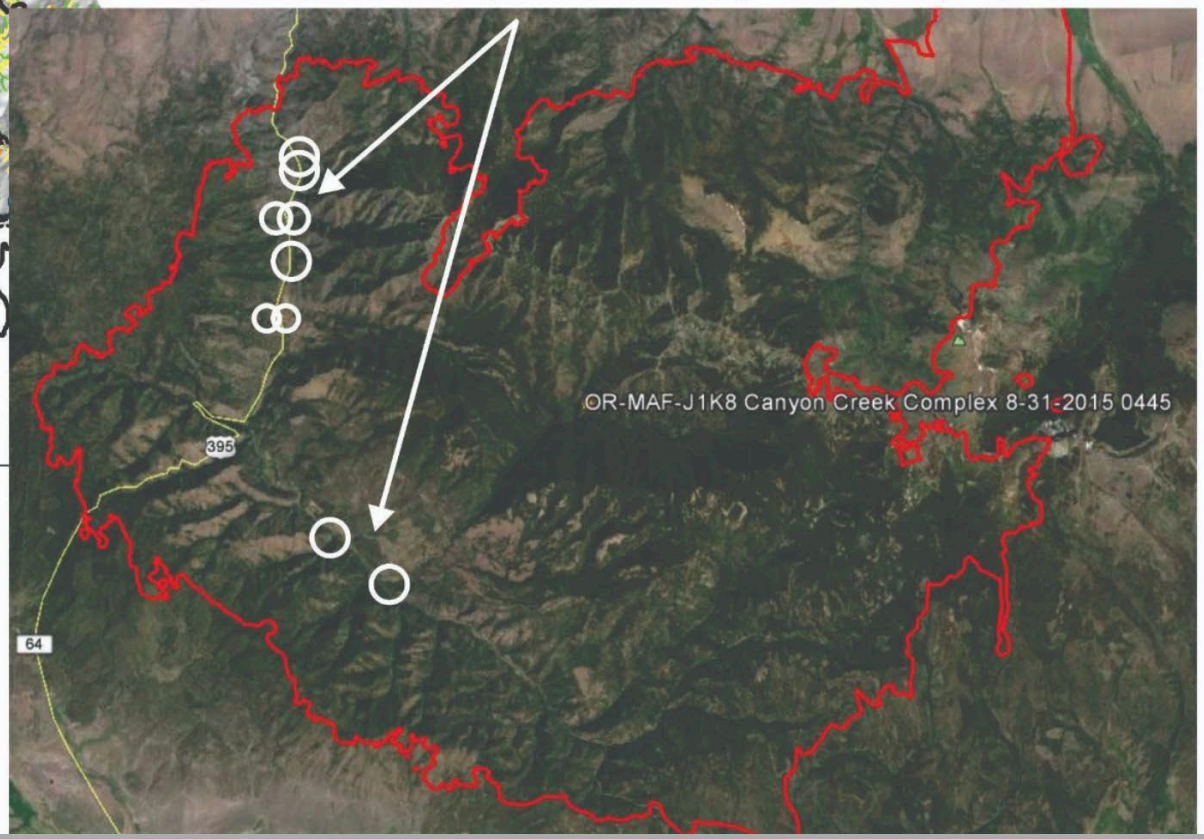


Erosion potential (slide) aggregated downstream (GEP_Cum)

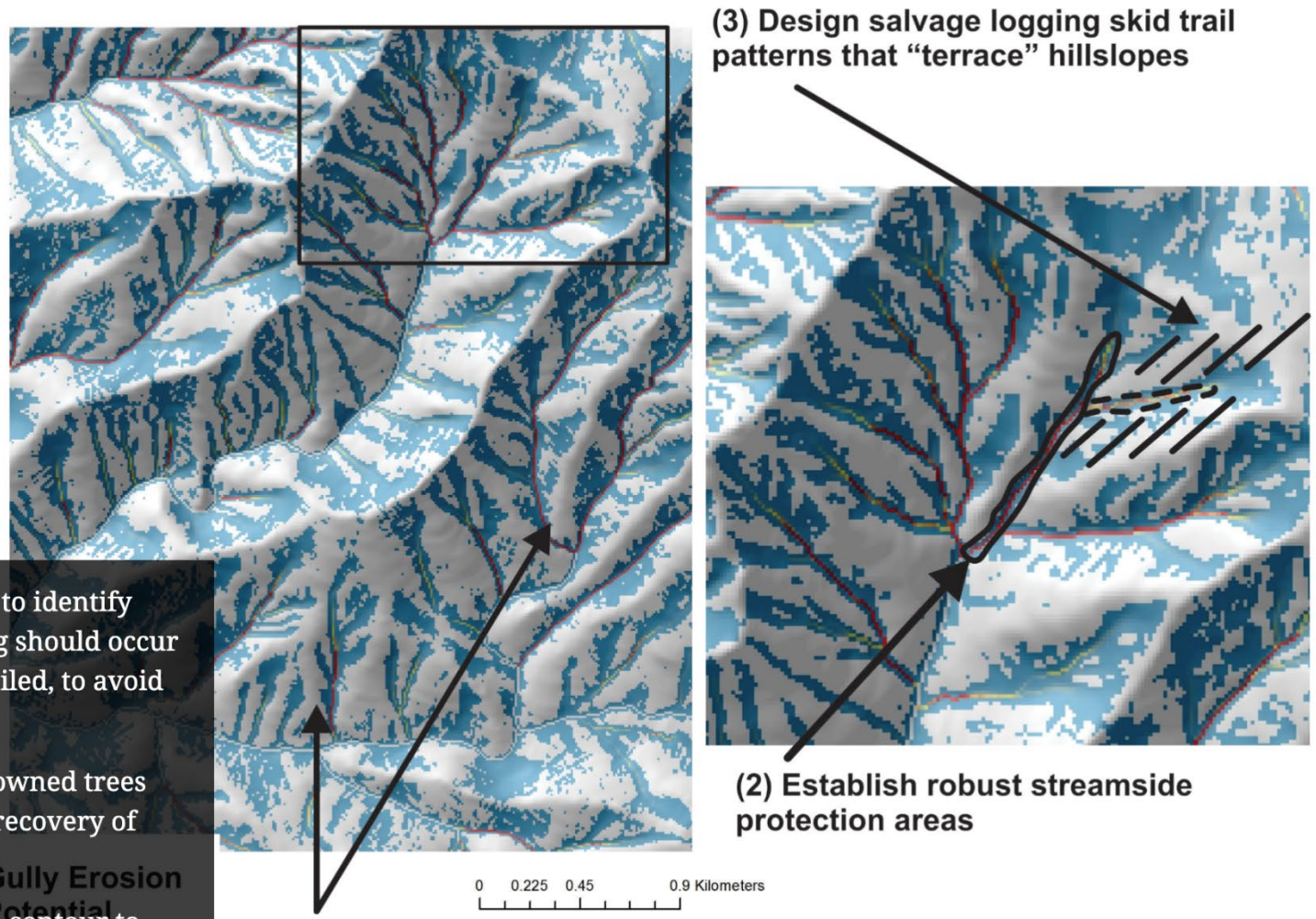
- 0.0193 - 0.2002
- 0.2003 - 0.3811
- 0.3812 - 0.5620
- 0.5621 - 0.7429
- 0.7430 - 0.9238

0 1.75 3.5

Potential at-risk highways and structures from post fire debris flows/flash floods (note, not comprehensive, just example)



Post Fire Salvage Logging Management Prescriptions



Use erosion potential maps to identify areas where salvage logging should occur and where it could be curtailed, to avoid accelerating problems.

Leave standing dead and downed trees along streams, to facilitate recovery of aquatic systems.

Drive machinery parallel to contour to break the baked soil and reduce the chance for runoff pathways.

Alternative View

- Wildfire is a natural process
- Fish populations have persisted for millennia in fire- and disturbance-prone landscapes
- ***Use fire as restoration tool?***

"The significant problems we face today cannot be solved with the same level of thinking that were at when we created them."

Albert Einstein

COLLABORATIVE PROCESS-BASED RESTORATION (PBR) OF AQUATIC HABITATS (PRESENTATION 4)

MILLER TIME: CHEERS TO PARTNERSHIPS AND PBR

Utah Division of Wildlife Resources

1

PARTNERSHIPS, IMPLEMENTATION AND OUTCOMES

2

PARTNERSHIPS

- BAER/ESR TEAMS
- UTAH'S WRI-FIRE REHABILITATION
- NGO'S
- AGENCY RESOURCE SPECIALISTS
- INDUSTRY
- LANDOWNERS

3

IDENTIFY ACHIEVABLE GOALS MEETING NEEDS OF PARTNERSHIP

4

UPLAND RESTORATION EFFORTS-2012

- Seeded annual sterile varieties
- Mulching
- High severity burn areas
- Slopes 30% or less
- Seeding the fall after the fire

5

STREAM RESTORATION-2016

- Tested process based restoration (PBR) technique
- Quick success
- Partnership grew

6

PLANNING-2017

- Built the partnership
- Secured funding
- Pre-treatment monitoring

7

STREAM RESTORATION-2018

- Worked on upper and lower reaches of Miller creek
- Contract crews, heavy equipment and more PBR

8

STREAM RESTORATION-2019

- More PBR
- Worked focused on lower reaches and re-vegetation
- More landowners reached out

9

STREAM RESTORATION-CONTINUES

- Contracting labor
  - 80+ low-tech structures annually
- Outreach effort have successfully broadened our work

Instagram

Miller Time Video

Wild Podcast

Watershed Restoration

10

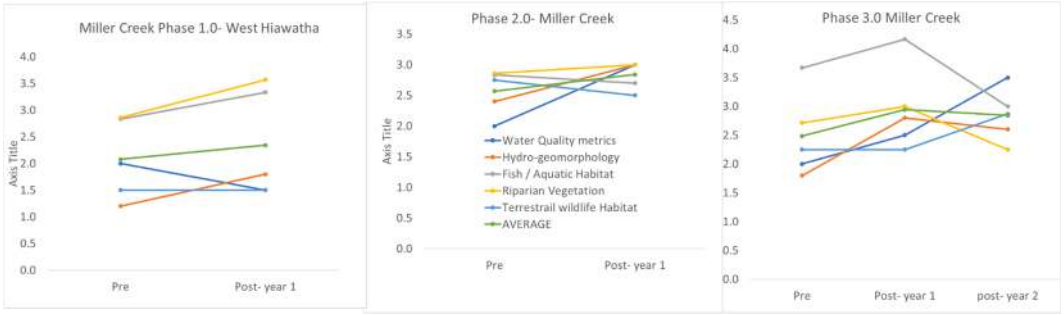
OUTCOMES

- Failures are successes too

11

OUTCOMES

- Monitoring shows improvements in ecological function of Miller creek



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OUTCOMES

- Transplanted fish in 2021

13

THANK YOU

14

INDIGENOUS LEADERSHIP IN WILDFIRE RECOVERY—ELEPHANT HILL WILDFIRE RESPONSE (PRESENTATION 5)

Indigenous wildfire recovery and restoration: lessons learned from the Elephant Hill wildfire

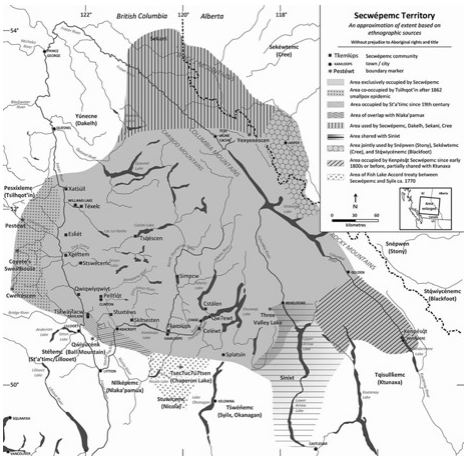
Angie Kane & Char John, SRSS and Sarah Dickson-Hoyle, UBC Forestry

Pacific Salmon Foundation Watershed Workshop. January 26, 2022

1

THE SECWEPEMCÚL'ECW RESTORATION AND STEWARDSHIP SOCIETY

- Founded by 8 Secwépemc communities
- Formed to advance sustainable management of *tmicw* (land) and resources
  - Indigenous restoration and stewardship
  - Adaptation to climate change
- Establish a foundation for collaboration and co-management for long-term restoration and resilience



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SRSS MEMBER COMMUNITIES

SKEETCHESTN INDIAN BAND

Whispering Pines / Clinton Indian Band

High Bar First Nations

TK'EMLÚPS TE SECWEPEMC

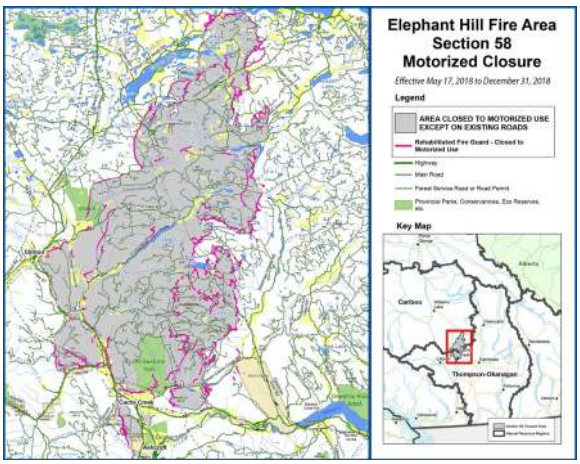
Canim Lake Band
The Tsq'escenemc
"The People of Broken Rock"

TS'KW'AYLAXW FIRST NATION

3

THE ELEPHANT HILL WILDFIRE

- 2017 – record-breaking wildfire season in BC
  - 1.2M ha burned, 65,000+ evacuated
- Elephant Hill wildfire
  - 3rd largest 'megafire'
  - Burned 192,000 ha throughout Secwepemcúl'ecw
  - 75 days, July – September
  - High severity - loss of trees, habitats, impacts to watersheds, loss of seed source/seedbanks for regeneration



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JOINT LEADERSHIP IN WILDFIRE RECOVERY

Joint Leadership Council and Joint Technical Committee

Partnership between:

- 8 affected Secwépemc communities
- BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD)
  - Regional Districts – 100 Mile House, Thompson Rivers
- BC Wildlife Branch
- Director of Resource Management, Thompson-Okanagan

JLC established to:

1. Develop shared vision and plan for post-wildfire recovery
2. Identify wildfire recovery and restoration funding and resources
3. Support First Nations led recovery

JTC to inform recommendations, provide technical guidance, develop principles

5

SRSS FOCUS: ELEPHANT HILL AND BEYOND

- Key projects include:
  - Elephant Hill riparian restoration project (BCSRIF funded – focus on salmon habitat)
  - Natural capital evaluation
  - Cultural heritage resources – monitoring and restoration
  - Carbon monitoring
  - Implementing Elephant Hill 'lessons learned'
- Supporting training/capacity building
- United voice and strengthened collaborations

6

‘LESSONS LEARNED’: PROJECT OVERVIEW

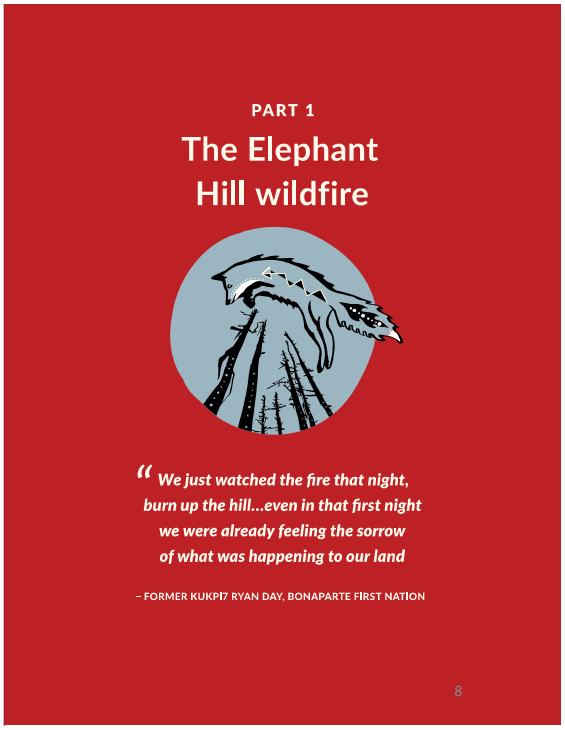
- SRSS & UBC Faculty of Forestry – guided by SRSS First Nations Technical Table and Board of Directors
- In-depth interviews and documentation of joint wildfire recovery, collating recovery data (salvage harvesting, rehabilitation, archaeology etc)

- Final report:
  - Documents Secwépemc & provincial experiences of 2017 wildfires
  - Examines drivers and process for joint recovery
  - Summarizes wildfire recovery activities and outcomes
  - Identifies ‘lessons’ from collaborative recovery
  - Highlights persistent barriers to, and Secwépemc priorities for, ‘true partnerships’ in wildfire management (including recovery)
  - Presents key findings and calls to action

7

WILDFIRE IMPACTS AND PRIORITIES FOR RESTORATION

“We’re tied to the land. When you walk across the land, you feel the people who were there before you.”



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"The government needs to understand the impact of this fire on our territories…that is our sustenance, that is our backyards, that is our livelihoods that we'll never see again… our plants, and our foods, and our medicines, and our culture, and everything that is being completely destroyed by the fire…it has huge social, cultural and economic impacts to us, 70% of our traditional territory is burnt…it is about our rights as Indigenous people living off the land…we don't have the resources to go hunting anymore, our waters are contaminated, our fishway has blown out, so Bonaparte in every way has been impacted with our right to occupy and use the land…And I don't think that that is taken seriously enough."

- JENNY ALLEN, ST'UXWTÉWS (BONAPARTE FIRST NATION)

9

WILDFIRE IMPACTS AND PRIORITIES FOR RESTORATION

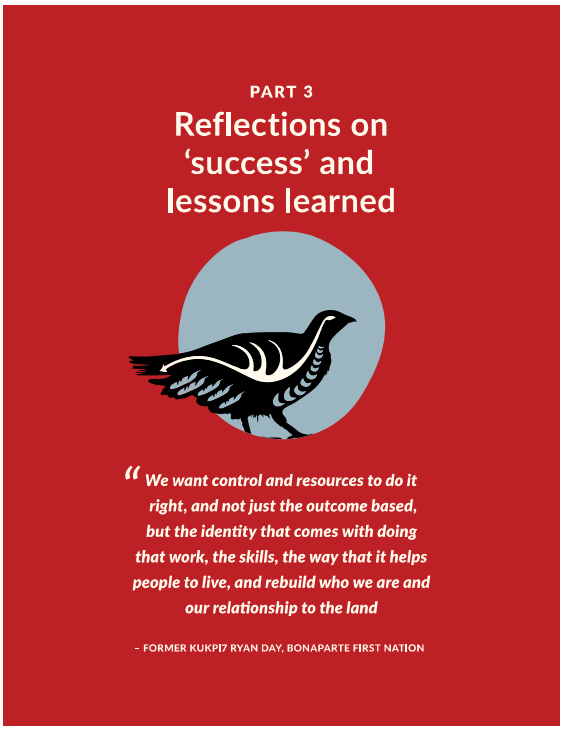
- Interconnected impacts to the land and to community health and wellbeing
  - Cultural heritage (fish and wildlife habitat, food and medicine plants, culturally significant sites, archaeological sites); access to territory
- Key concerns: impact of salvage harvesting, increased hunting access, flooding/landslides, long-term impact on salmon populations
- Priority: ensuring Secwépemc leadership in decisions affecting recovery of their territories

10

LESSONS FROM JOINT RECOVERY

"You just want to run out there and do everything, but slow it down, slow it down. It'll get done but slow it down. This land is our land. Gotta remember that."

ELEPHANT HILL: SECWÉPEMC LEADERSHIP AND LESSONS LEARNED



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"The social and cultural processes that were developed and relationships that were affirmed are absolutely the biggest success. And not because they solved all the problems. But because it established a new way of doing things that will allow us to solve the bigger problems that are coming. I think often of climate change and the kinds of action that we're going to have to take collectively to be able to manage the impacts of climate change. It's going to take those kinds of organizations and relationships to do it. We would never be able to tackle it under the old winner takes all, government regulating industry sort of system and leaving First Nations and communities out of the loop. That was never going to work. So I think that that is a major, a major victory."

- JOANNE HAMMOND (SKEETCHESTN NATURAL RESOURCES)

INDIGENOUS WILDFIRE RECOVERY: LESSONS FROM ELEPHANT HILL 12

12

LESSONS FROM JOINT RECOVERY

- Widely viewed as 'successful' – building trust & new relationships, building capacity, establishing a precedent for joint recovery
- Key to this success was strong leadership and governance structure; identifying shared values and priorities; time *in communities* to build trust
- But….
  - Lack of landscape level planning
  - Challenges with participation and capacity
  - Conflicting perspectives on and approaches to 'recovery'
- Elephant Hill as a 'model'?
  - First Nations determine approach to land-based recovery
  - Jointly determine goals, principles, planning

KEY FINDINGS & RECOMMENDATIONS

- 30 recommendations ('calls to action')
  - Organized around mitigation and preparation, response, and *recovery*
- Build on 'lessons' (strengths, successes, challenges) of Elephant Hill
- BUT: Risks of narrow view of 'model' or 'template' for recovery
  - Prioritizing pre-defined 'operational' outcomes over meaningful collaboration and joint decision-making

#10: ESTABLISH PROVINCIAL WILDFIRE RECOVERY FRAMEWORK

INDIGENOUS WILDFIRE RECOVERY: LESSONS FROM ELEPHANT HILL

15

Photo credit: Paul Simakoff-Ellims

15

#19, 21 -24: CO-DEVELOP, FUND AND IMPLEMENT STRATEGIC WILDFIRE RECOVERY

INDIGENOUS WILDFIRE RECOVERY: LESSONS FROM ELEPHANT HILL

16

KNUCWENTWÉCW-KT ES PELQENTÉM RE TMICW TE M-QWEMPÚLECW TE TSERTSERPÚLECW, ELL ES YECWMENÚLECW-KT

Knucwentwécw-kt ne7áye ne Secwepemcúlecw re Secwépemc ell re tíkwenm7ple7s re B.C. es pelqentém re tmicw te m-qwempúlecw te tsertserpúlecw te pts7emétś "Elephant Hill Wildfire" te tálmes te m-sq7es re stetex7ém-kt re syecwmins, ell es yecwmenúlecw-kt cú7tsem xwexwéyt re stem ne tmicw-kt.

Ye7éne me7 tsetsúwet-kt:

- Me7 tásulecwentem thé7e k qwempúlecwes.
- Me7 knucwentwécw-kt es yecwmenúlecwmentem es kúlem-kt te tálmes te m-sq7es wel me7 yews.
- Me7 xpqenwéntem tkenhé7e me xálttmes es p7ecws re sle7s re syecwmenúlecwems ne xwexwéyt re Secwepemcúlecw.

"Me7 élkstmentwécwmentem es yecwmíntem re tmicw-kt wel me7 yews. Tálem yeri7 te swuméc-kt re tmicw-kt, tikwemtús me7 re syecwmenúlecw-kt tálem te m-sq'7es le stetex7ém-kt."

COLLABORATION ON WILDFIRE RECOVERY AND LAND MANAGEMENT

Secwépemc communities and the Province of B.C. are working collaboratively on wildfire recovery and land base management in the Elephant Hill Wildfire area and surrounding area.

Activities associated with the Elephant Hill Wildfire area include:

- Secwépemc Territorial Patrols,
- Collaborative recovery and management initiatives,
- Guidance for forestry activities and other economic development.

"Working towards a thriving and sustainable relationship in stewardship"

16

#8, 27-30: PROTECT AND REVITALIZE ARCHAEOLOGY AND CULTURAL HERITAGE

INDIGENOUS WILDFIRE RECOVERY: LESSONS FROM ELEPHANT HILL

17

Photo credit: Joanne Hammond/SNR

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MOVING FORWARD: KEY QUESTIONS & TAKEAWAYS

What is the role of First Nations/communities in wildfire recovery? In (developing) this playbook?

"Projects that don't involve First Nations from the get-go don't work."

- Joint planning and relationship building must be the first step in wildfire recovery
  - Collectively assess impacts, define recovery priorities and approaches
- 'Walking on two legs': Indigenous and western science

19

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G2G POST-WILDFIRE INITIATIVE– ELEPHANT HILL WILDFIRE RESPONSE AND RECOVERY (PRESENTATION 6)

Post Wildfire Land-base Recovery: A strategic overview of the Elephant Hill G2G Initiative (from the Provincial governments perspective).

Rachael Pollard – A/Director of Forest Sciences, Planning and Practices Branch, Office of the Chief Forester, FLNRORD

Eric Valdal – Director of Resource Management, Thompson-Okanagan Region, FLNRORD

January 26, 2022

1

Outline

1. Background and Context
2. The Elephant Hill (EH) Approach
3. Select EH Initiatives associated with watershed function, fish habitat, fish
4. Concluding thoughts

2

2

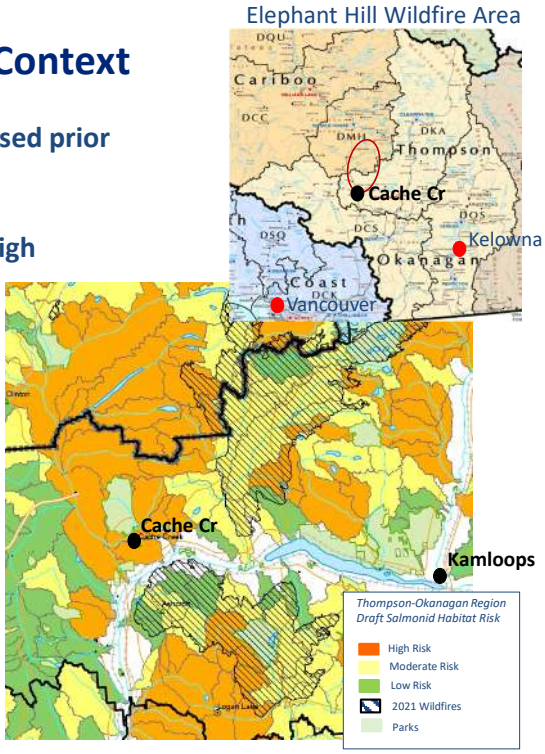
Background

- 2017 - Both the federal and provincial governments committed to reconciliation and implementing UNDRIP
- Starting July 2017 - the 2017 EH Wildfire burned ~191,000 ha of Secwepemc traditional territory in both the Cariboo and TO Regions
- G2G agreement to work together on post-wildfire restoration, using a landscape-level approach

3

Landscape/Watershed Context

- Watershed function compromised prior to wildfire disturbances
- High Risk the combination of high hazards for:
  - Riparian Function
  - Roads/Sedimentation
  - Equivalent Cleared Area



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The Elephant Hill Approach

- **Government-to-Government Collaboration:**
  - Shared decision making supported by a Leadership Table (Secwepemc Kukukpi7 and Provincial Directors)
  - Collaborative Retention Plan developed by collaborative technical tables and signed off by Leadership Tables
- **'Health of the Land First':**
  - Common goal of considering recovery from the perspective of the land/watershed
- **Core Objectives – the "What"**
  - Fire guard rehabilitation
  - Salvage of dead stands
  - Range Recovery
  - Reforesting salvaged and non-salvaged areas
- **Core Objectives – the "How"**
  - Collaborate with FN
  - Consistent with Chief Forester Guidance

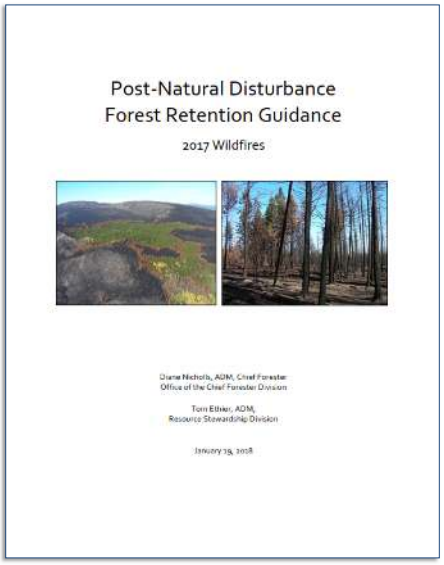
Riparian Monitoring Training Session for Secwepemc and Prov gov staff

5

Chief Forester's Retention Guidance

Planning emphasis on what to leave, prioritizing:

1. **Human safety and infrastructure**
2. **Sustain, enhance and recover ecosystems**
3. **Consider cumulative impacts**
4. **Facilitate adaptation – climate resilience**
5. **Minimize impacts to timber supply**
6. **Recover value from burn timber**



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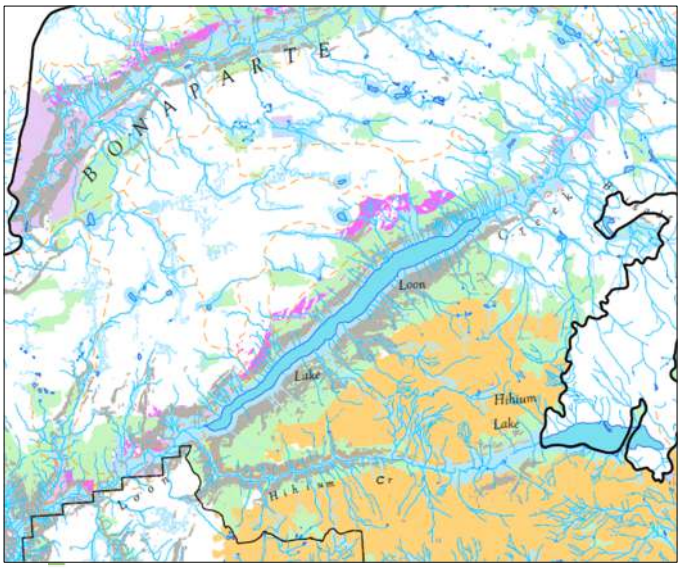
Select Recovery Initiatives (assoc. with watershed function, fish habitat, fish)

- Strategic Retention Salvage Guidance
- Fireguard rehab
- Reforestation to recover riparian areas and hydrologically sensitive zones and forest ecosys.
- Collaborative Monitoring
- Steelhead – Assisted Migration
- Motor Vehicle Closures

Coloured areas of map represent retention guidance categories



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7

(Some) Concluding Thoughts

- Elements of success:
  - Importance of a joint leadership council for guidance
  - North Star: health of the land first and foremost
  - Salvage/retention planning and silviculture activities focussed on multiple values
- Recovery takes a long time
  - Reforestation and other recovery initiatives still underway
  - Longer term restoration initiatives started

EH G2G Silviculture Field Trip

8

8

COLLABORATIVE RESPONSE TO ECOSYSTEM RESTORATION AFTER THE SHOVEL LAKE AND ISLAND LAKE WILDFIRES (PRESENTATION 7)

Shovel Lake/ Island Lake Wildfire

ECOSYSTEM RESTORATION PLANS:

A COLLABORATIVE APPROACH

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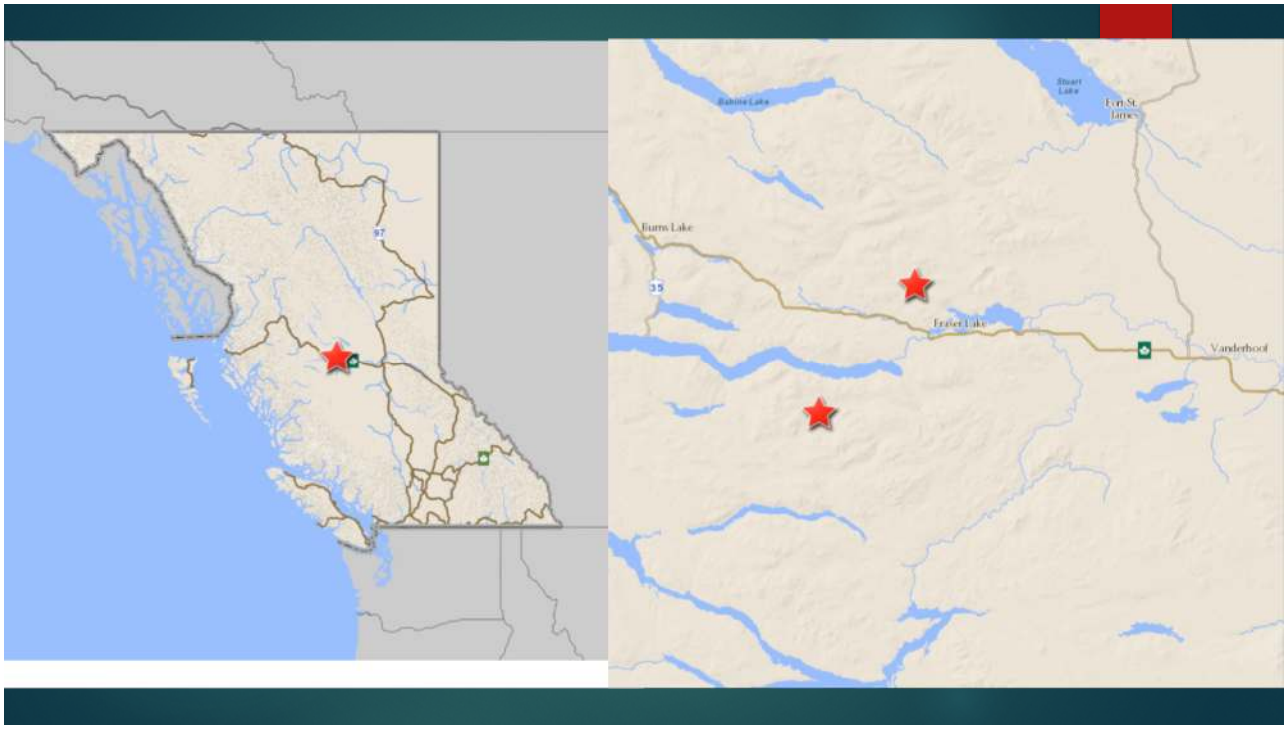

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Yun Ghunli:
"People Who Watch Over The Land"

- Stellat'en First Nation
- Nadleh Whut'en
- Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD)
- Society for Ecosystem Restoration in Northern BC (SERNbc)

3

Shovel and Island Lake ERPs - the principles

- Collaborate with First Nations' communities impacted by the fires
- Promote ecological integrity and resilience
- Coordinate with other programs

4

Shovel and Island Lake ERPs - the values

5

Shovel and Island Lake ERPs - the values

- Timber
- Range

6

Shovel and Island Lake ERPs - the values

- Forest biodiversity
- Landscape connectivity
- Watershed health

7

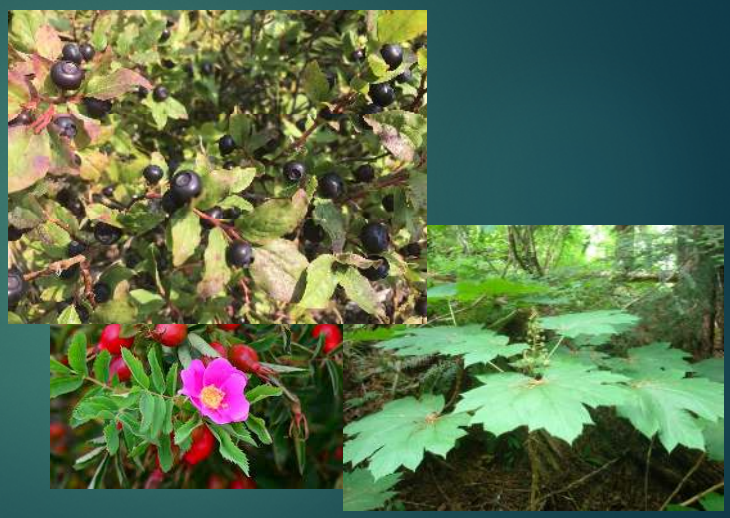
Shovel and Island Lake ERPs - the values

- Moose
- Furbearers
- Grizzly bears
- Goshawks

8

Shovel and Island Lake ERPs - the values

- Cultural areas
- Berries
- Medicinal plants
- Mushrooms



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Restoration Zones

Priorities for treatment are guided by zoning that shows the potential of each area to support values

- Wildland Urban Interface
- Fire Guards
- Special Restoration Zone
- Timber Restoration Zone

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Wildland Urban Interface Zone

11

Special Restoration Zone

12

Special Restoration Zone Priorities

- Maintain/restore forest biodiversity and ecological function
- Increase resilience
- Maintain/restore watershed health and fish habitat
- Maintain/restore habitat for moose, grizzly bear, goshawk, furbearers
- Maintain/restore cultural resources
- Maintain/restore berry habitat
- Maintain/restore medicinal plant habitat
- Manage mushroom harvest

13

Timber Restoration Zone

14

Timber Restoration Zone Priorities

- Maintain mid-term timber supply
- Provide access to short-term timber supply for sawlog and/or biomass
- Increase resilience

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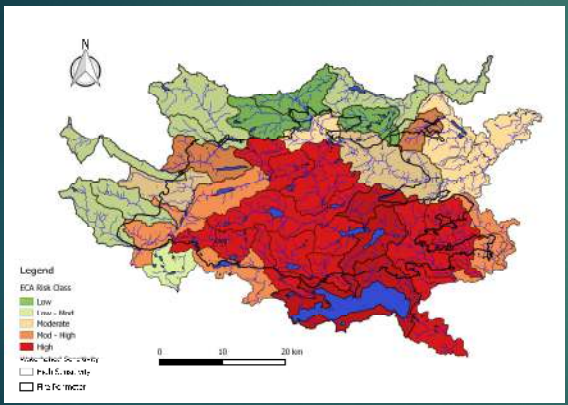
Watershed Health and Riparian values



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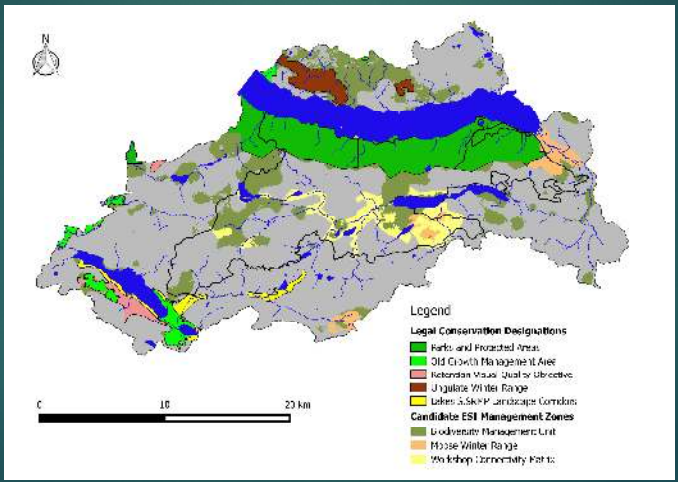
Restoration Treatment Zones – Island Lake



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So what does this all mean on the ground?

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Salvage Logging

BY THE ZONES …

19

age class	burn severity	Timber Restoration Zone	Riparian areas (and adjacent steep slope)	Special Restoration Zone		WUI Zone
				Biodiversity, OGMA, FEN	Moose UWR	
ALL	unburned-light	retain for mid-term timber supply				**Reduce fuel hazards:** remove smaller-diameter conifers retaining large trees and snags; remove decked wood; remove downed wood and fine fuels
0-40	mod-severe	minimize soil disturbance		retain all live trees and shrubs; minimize soil disturbance	retain all live trees and shrubs; minimize soil disturbance	
40-100	mod-severe	retain all live tree patches; minimize soil disturbance		retain all live tree patches, all live Fd, all large live and dead trees/snags; minimize soil disturbance; use existing roads	partial salvage OK (mobility); retain all live trees, all deciduous trees and shrubs, snag patches; avoid moist/rich sites (retain as WTP); minimize soil disturbance; use existing roads	
100+	mod-severe	retain all live tree patches and large snags; minimize soil disturbance		where possible, allow to recover naturally	partial salvage OK (mobility); retain all live trees, all deciduous trees and shrubs, snag patches; avoid moist/rich sites (WTP); minimize soil disturbance; use existing roads	

20

Silviculture

BY THE ZONES …

21

Timber Restoration Zone	Riparian areas (and adjacent steep slope)	Special Restoration Zone		WUI Zone
		Biodiversity, OGMA, FEN	Moose UWR	
Prioritize: Fireguards and roads ID'd for rehabilitation Severely burned steep slopes	Prioritize: Severely-burned riparian areas and adjacent steep slopes	Prioritize: Fireguards and roads ID'd for rehabilitation Severely burned steep slopes	Prioritize: Fireguards and roads ID'd for rehabilitation Severely burned steep slopes	Prioritize: Public safety, resilience and resistance to future wildfire
Where possible, leave to regenerate naturally (more diverse, more resilient)	Seed erodible soil with fall rye for immediate protection	Where possible, leave to regenerate naturally (more diverse, more resilient)	Where possible, leave to regenerate naturally (more diverse, more resilient) Maintain mosaic of forage and cover	Reduce coniferous stocking; reduce or remove stocking standards
Plant: Diverse range of climate-adapted species Varied density and patterns	Plant or encourage: * aspen * willow * red-osier dogwood	Cluster-plant climatically-adapted species Leave room for naturally-regenerating willow, alder, dogwood, aspen, cottonwood Where appropriate, leave space for planting berries and medicinal plants No brushing or herbicide	Plant cover patches if not regenerating naturally Promote shrub growth especially in moist, rich areas (do not plant conifers); plant willow and dogwood if appropriate No brushing or herbicide	Encourage deciduous species, especially around communities
		Avoid planting in wet, rich site series (high deciduous potential)		Needs Community Wildfire Protection Plan to guide activities
		Dry site series may shift to open grassland Avoid planting, or plant widely-spaced Fd, saskatoon, rocky mountain juniper		

22

Costs, Stocking Standards and Implications for Timber Supply

23

Next steps

- Build relationships with Districts and licencees
- Seek cooperation, collaboration
- Assess costs, access funding
- Monitor, research, learn and adapt

24

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GIS TOOL FOR RAPID POST-WILDFIRE WATERSHED ASSESSMENTS (PRESENTATION 8)

A GIS Indicator-Based Approach for Rapid Post-Wildfire Watershed Assessment

The 2017 Elephant Hill Wildfire Example

Doug Lewis, RPF - BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development

Photo of Elephant Hill Wildfire – September 2017: Rita Winkler

1

Acknowledgements

- Micheal Milne- MJ Milne & Associates Ltd
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- Rita Winkler
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- John Rex
- Kim Green
- Natasha Neumann
- Younes Allila
- Martin Carver
- Greg Utzig
- Dave Wilford
- Lisa Nordin
- Lars Reese-Hansen
- Russel Smith
- Lars Unilla

David Huggard, Forest Ecologist - MPB effects on ECA

GIS Wizards

- Graham MacGregor
- Sasha Lees

Cumulative Effects Program

- Robin Hoffos/Eric Valdal/Chelsea Enslow/Cheryl Williston

Forsite Consultants Ltd.,

- Cam Brown
- Randy Spyksma
- Breck Alward
- Stephen Smyrl

2

GIS Indicator-Based Approaches in BC

LDWF1

Based on:

- Watershed Assessment Procedure (WAP; 1999)
- Carver and Utzig, 1999- GIS-based Hydrologic Screening Decision Support Tool- Kootenay Region https://www.for.gov.bc.ca/hfd/library/documents/bib96785.pdf
- Green,K. 2005. Qualitative Hydrogeomorphic Risk Analysis for British Columbia's interior watersheds
- Kamloops TSA watershed screening tool (Brown et al. 2007)

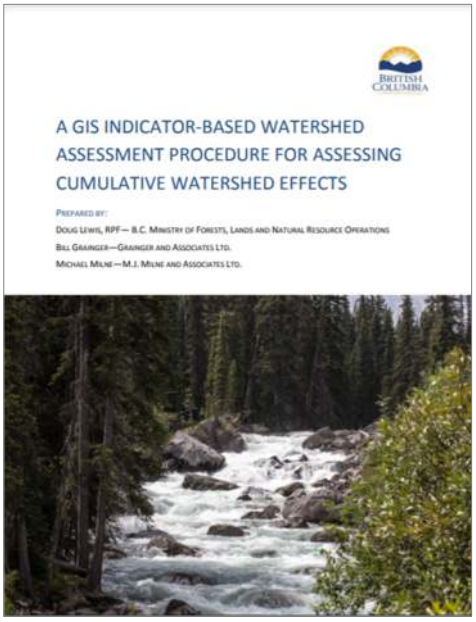
Current Region and Provincial Application of this approach

- Thompson-Okanagan/Cariboo (Chelsea Enslow/Cheryl Williston)
- Kootenay-Boundary (Natasha Neumann)
- Omenica (John Rex)
- Provincial (Lisa Nordin)

3

Overview

- Strategic watershed assessment procedure to quantify relative potential hydrologic hazard,
- Suitable for large areas (millions of hectares) and numerous watersheds.
- Identify where elevated risk to downstream elements;
  - domestic water intakes,
  - private property,
  - public infrastructure (roads, bridges),
  - fish and fish habitat
- Assist in prioritizing and proactively directing resources into select higher risk catchments to further assess and manage risk.



[1] https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/cumulative-effects/watershed_assessment_procedure_final.pdf

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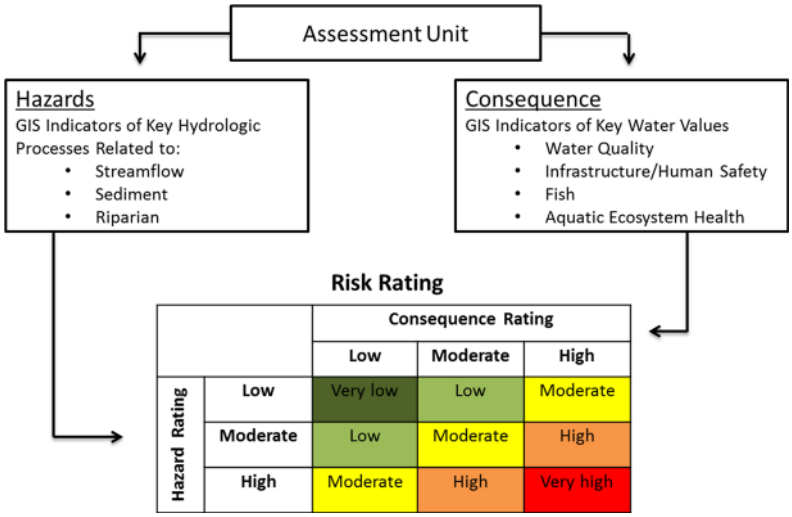
Risk-Based Approach



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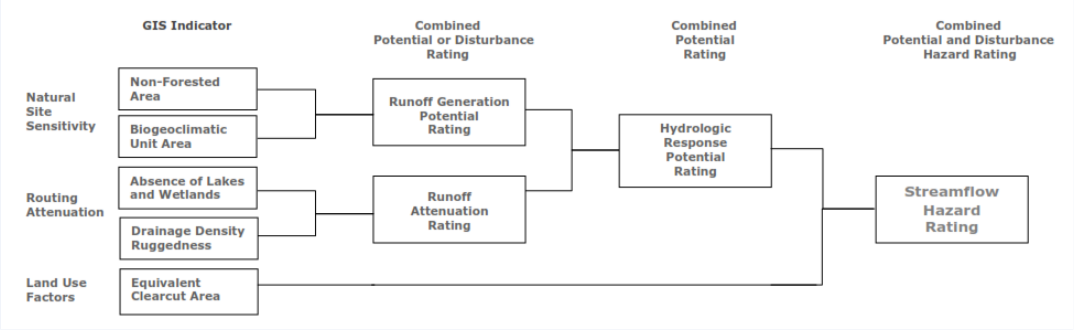
GIS-Based Indicators



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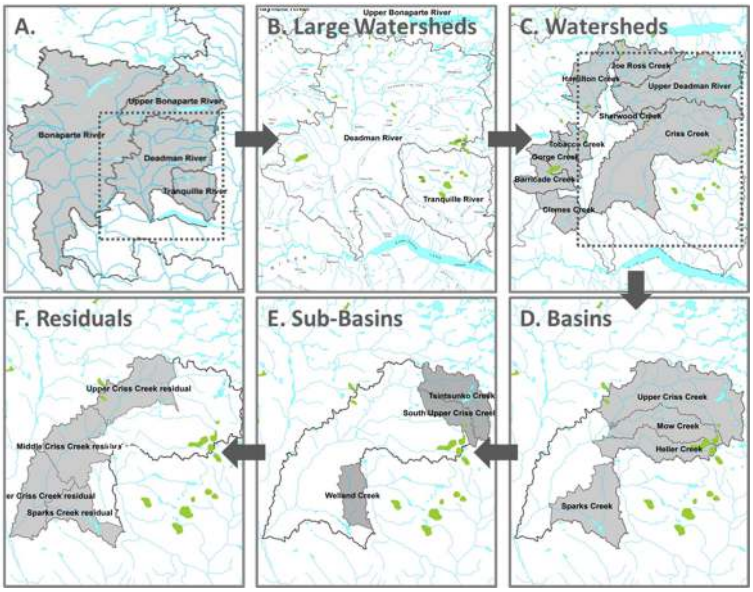
Multi-Scale Assessment Units (AUs)

- GIS indicators and ratings generated for each AU
- Choose appropriate AU based on Point of Interest (POI) specific to each element at risk



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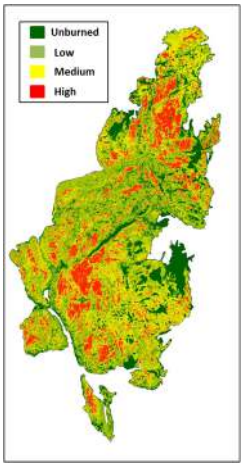
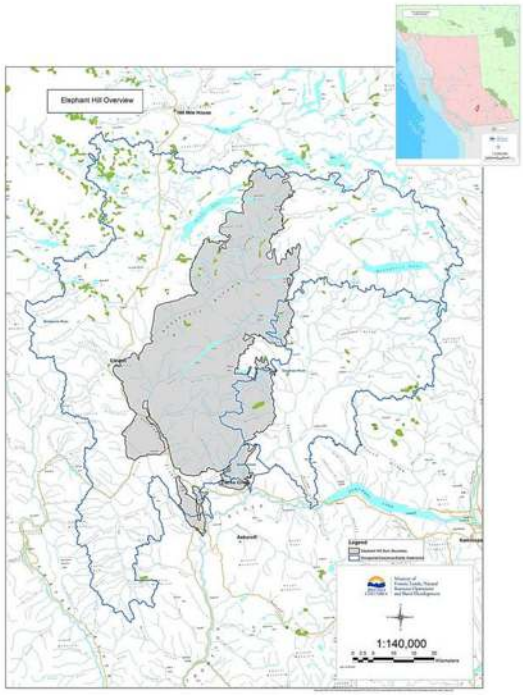
Elephant Hill Wildfire Overview

- Initiated summer 2017.
- Affected 192,000ha (192Km^2).
- ~20km x 90km in size.
- Over 140 Aus affected, including the Bonaparte and Deadman River watersheds and numerous smaller AUs within.





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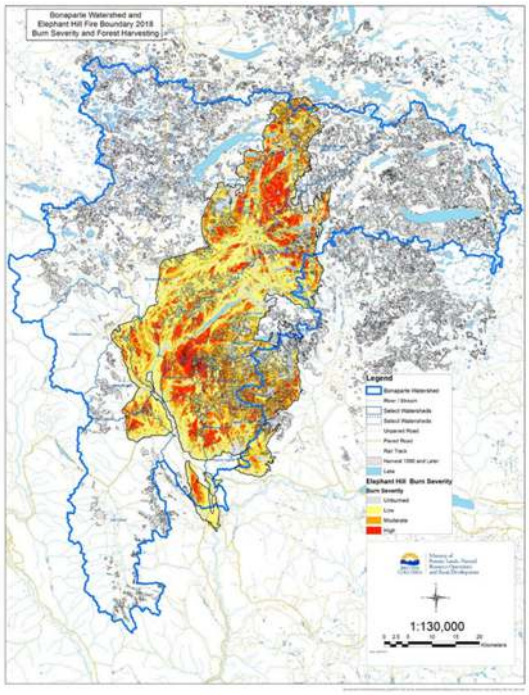
Post-Wildfire Decision Support Needs

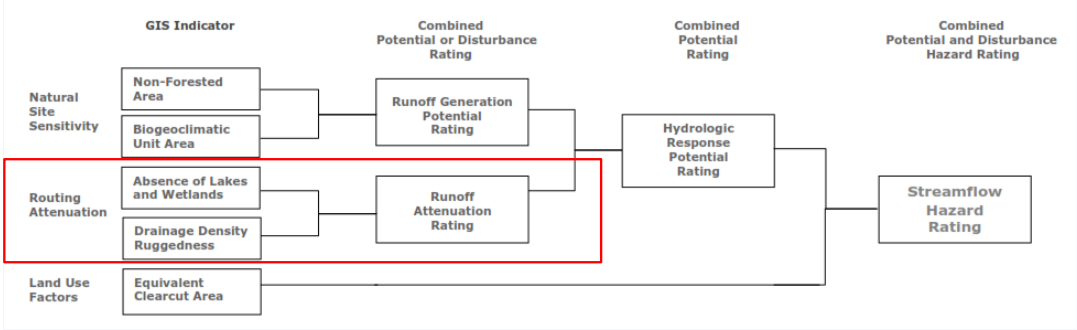
Rapid, preliminary assessment of impacts of wildfire, *and pre-disturbance landscape condition*, on multiple watershed assessment units and elements at risk:

- Identify priority areas for immediate attention:
  - Private property, human safety.
  - MOTI – infrastructure (highway sections, bridges) at risk.
  - Inform salvage response.
- Identify long-term management concern areas
  - Recovery and rehabilitation efforts for fish, aquatic habitat.



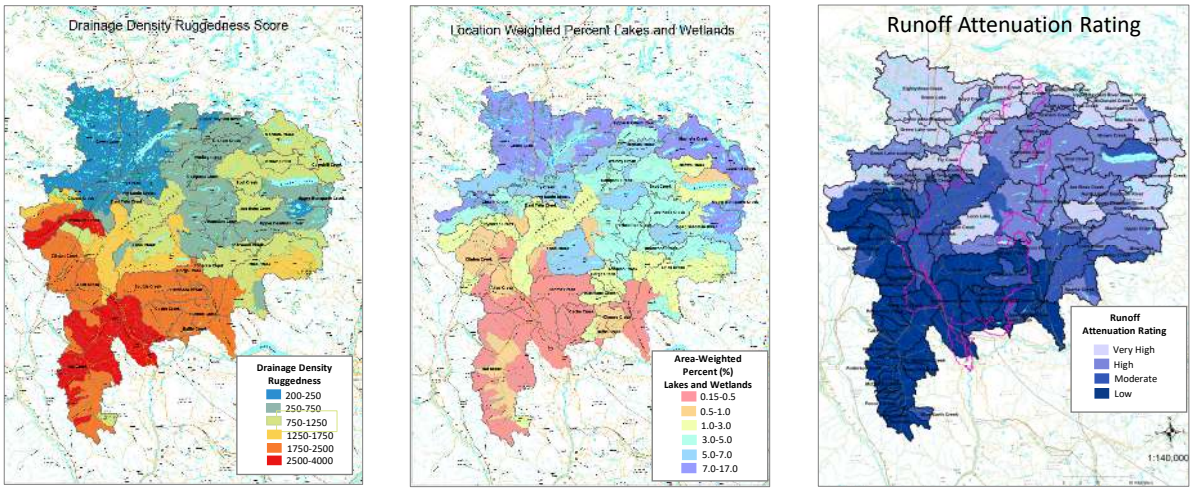
9

GIS-Based Indicators: Characterizing Runoff Response



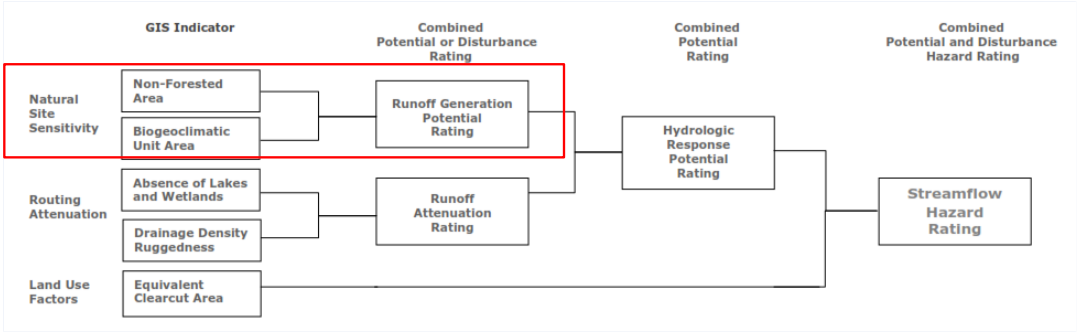
10

Runoff Attenuation Rating



11

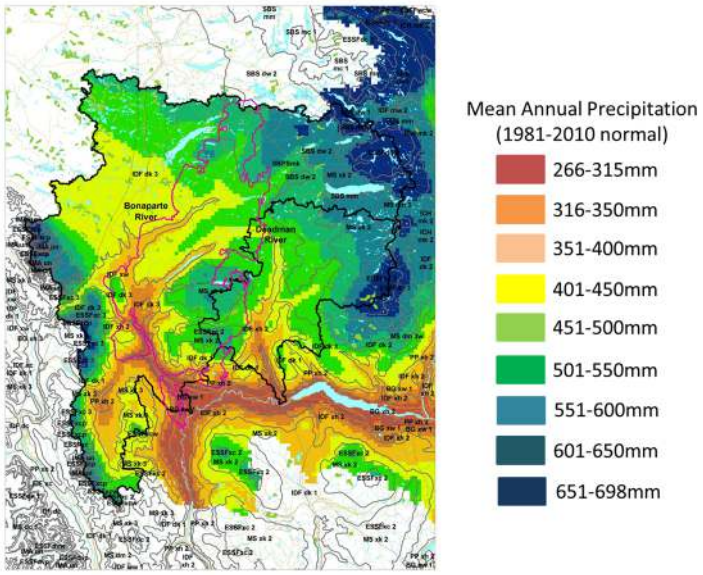
GIS-Based Indicators: Runoff Generation



12

Precipitation is a Big Driver

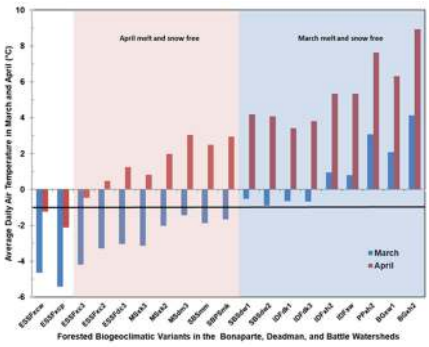
- Snowmelt (nival) dominated hydrologic regime.
- Precipitation varies significantly by elevation.
- Large portion of annual precipitation falls during fall/winter.
- Snowpack persists at higher elevations into April/May.

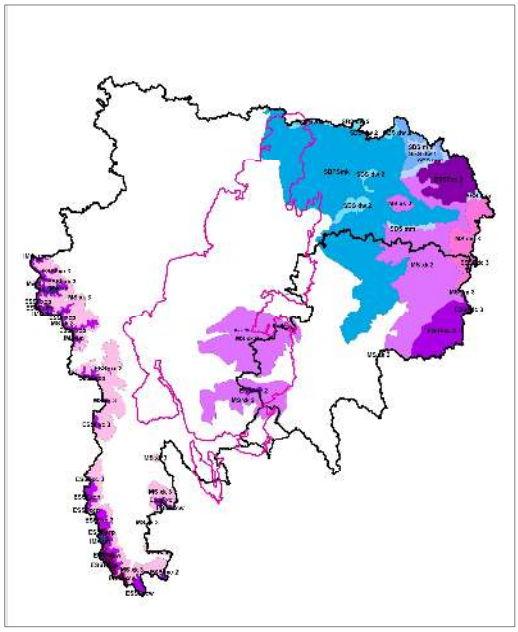


13

Biogeoclimatic Unit Area Indicator

- Area contributing snowmelt runoff to spring peak flow delineated using Biogeoclimatic subzones.

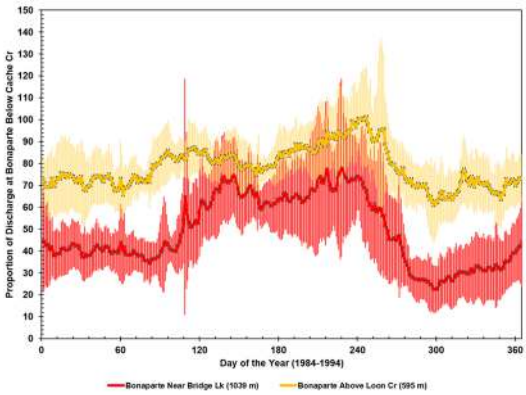


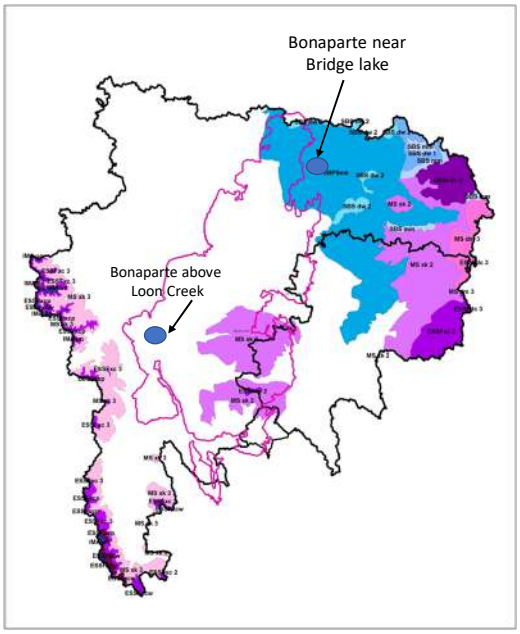


14

Snow Contributing Area and Watershed Hydrology

- Snow contributing zone is a small portion of watershed but contributes 50-80% of the water to the Bonaparte system.

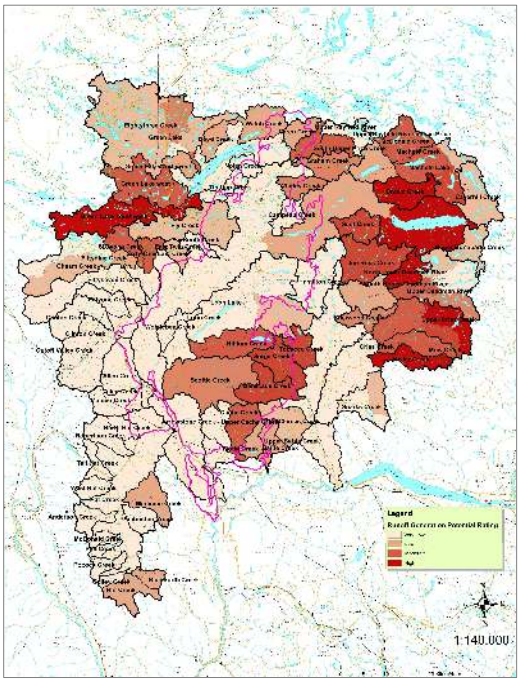




15

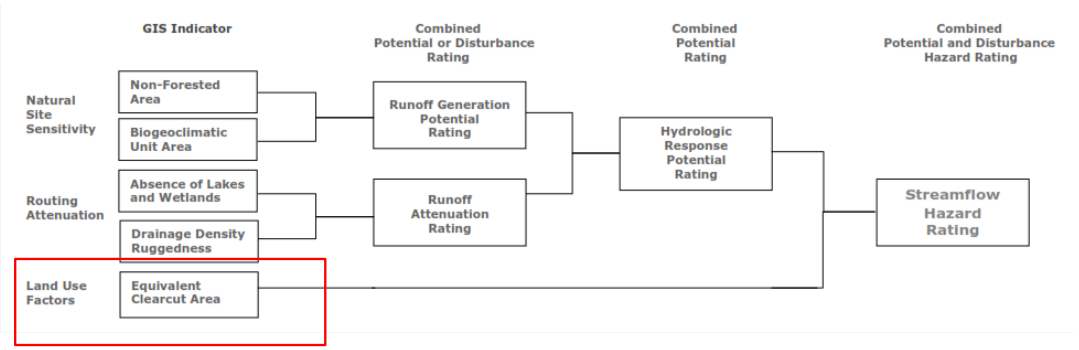
Runoff Generation Potential Rating

- AUs more likely to generate additional runoff that contributes to spring peak flows due to loss of forest cover.



16

GIS-Based Indicators: Forest Cover Loss and



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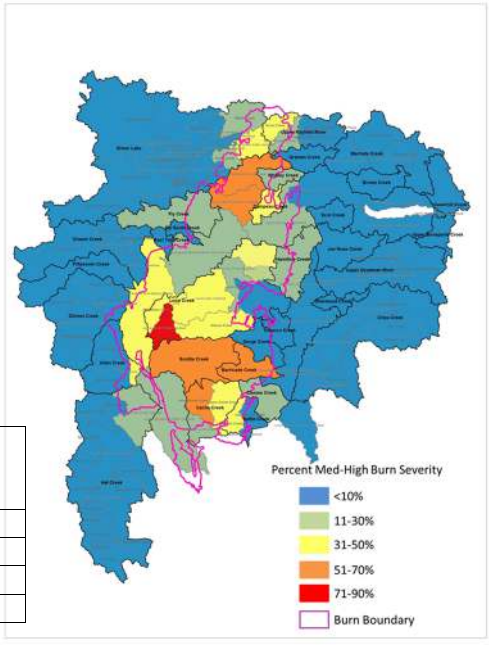
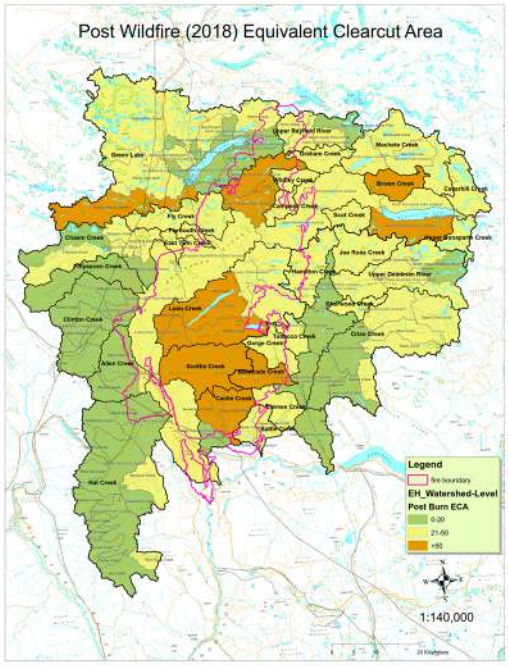
Equivalent Clearcut Area

- Equivalent Clearcut Area (ECA) is a commonly used measure of the extent of area of forest disturbed, accounting for re-growth.
- ECA related to snowmelt and snow accumulation processes in forests.
- ECA accounts for existing relatively permanent land use (e.g. urban, agriculture, mines, right-of-ways, pipelines, transmission lines, railways) as well as cutblocks & MPB-affected forests that regenerate over time.
- Overlaid the burn severity mapping and applied a burn severity coefficient to modify ECA for wildfire-affected stands.

Burn Severity Class	Percent (%) Overstory Tree Mortality	Burn Severity Coefficient
Unburned	0-20	0
Low	30% (20-50%)	0.1
Medium	70% (50-90%)	0.5
High	>90%	0.8



18



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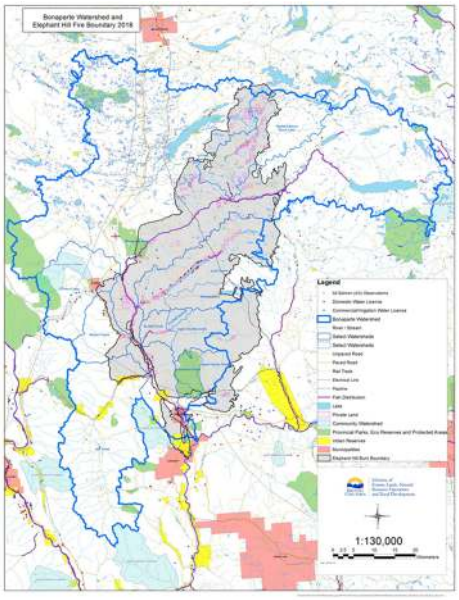
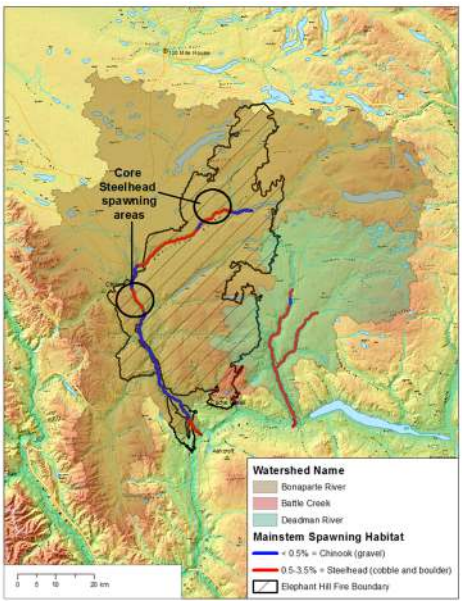
Elements at Risk





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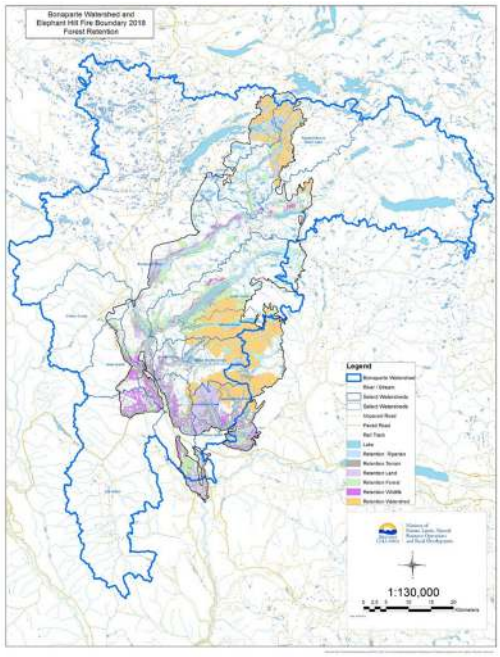
Salvage/Retention Guidance

- Watershed information informed salvage/retention strategy
- Full Retention/No Harvest in snow contributing areas affected by wildfire, unless:
  - More detailed hydrologic assessment completed to form a salvage/retention and runoff management plan
  - Salvage and quick regeneration could hasten recovery.



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Conclusions

- Strategic GIS indicator-based assessment procedures are useful at a broad-scale to:
  - Characterize watershed hydrologic processes (snowmelt runoff, attenuation)
  - Understand implications of large-scale wildfire coupled with existing disturbance
  - Hi-light watershed of management concern based on extent of disturbance, expected hydrologic response and downstream consequence
  - Direct resources for further field-based investigation/assessment
  - Focus management attention to avoid or mitigate risks
- Don't Replace field-based assessments
- More detailed, field-based assessments by qualified professionals required to assess risk and provide options to mitigate risk at watershed sclaes


Upper Scottie Creek Post wildfire – Fall 2018 Photo: Doug Lewis

22

EN ROUTE TO THE WILDFIRE RECOVERY PLAYBOOK (PRESENTATION 9)

EN ROUTE TO A WATERSHED RECOVERY PLAYBOOK

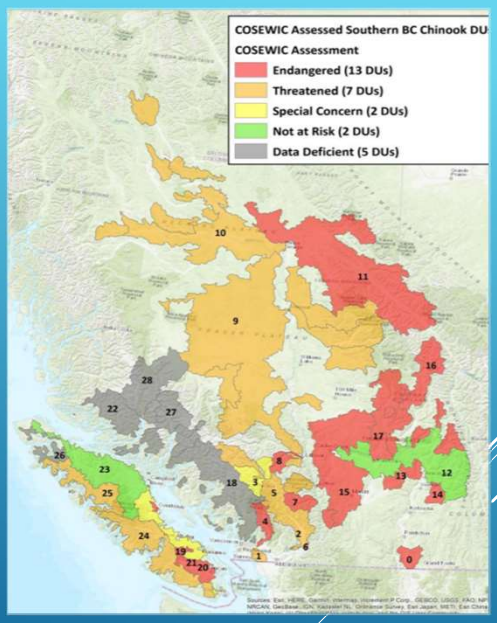
Pacific Salmon Foundation
Workshop on Post Wildfire
Watershed Recovery – Jan. 26, 2022

Jeff Morgan, M.Sc.

1

PACIFIC SALMON POPULATIONS IN CRISES

- 50 Pacific salmon populations are currently under consideration for potential listing under the *Species at Risk Act*, or pending assessment by the Committee on the Status of Endangered Wildlife in Canada (DFO – PSSI News release 2021).
- On the South Coast, COSEWIC has designated 48 populations (Designated Units)as Special Concern, Threated, Endangered or Extinct.*
  - All were chinook, coho, sockeye or steelhead!



* Derived from DFO Consultation Presentation, Jan 20, 2022
- Fraser and Approach Salmon Forum (figure also)

2

SALMON DECLINES AND THE IMPORTANCE OF FRESHWATER HABITAT

- Usual suspects - Ocean Productivity, Competition, Predation, Disease, Harvest and Freshwater Habitat Conditions
- Anthropogenic freshwater impacts – habitat alteration, pollution, water withdrawals, barriers, invasive species……and **cumulative effects**.
- Salmon are anadromous – spawn and incubate eggs in freshwater AND……..
- Coho, chinook, sockeye, and steelhead pops also **REAR** in freshwater – often through risky periods: late summer low flows and winter periods.
  - Watersheds are relatively unstable: the hydrograph - the master habitat variable - changes within and between years.
  - Stochastic weather events change flows and therefore the hydrograph.
  - High flows, flooding, raised water temperatures can all negatively impact salmon habitat and survival – both directly and indirectly.
  - Freshwater habitats (nurseries)are extremely important - high smolt production for these spp. often viewed as an antidote to other population impactors.
  - **Freshwater rearing species account for almost all of the salmon populations in BC that are risk!**

3

CLIMATE CHANGE AND HABITAT- AN AMPLIFICATION OF RISK

- Hydrographs (stream flows over time) are influenced by weather events.
- Stream flows shape steam morphology, sediment transport, habitat quality and quantity, water temperature, vulnerability to predation etc.
- Climate Change will increase the frequency and severity of:
  - droughts, atmospheric rivers, high and low flow events and floods and thus will significantly alter hydrographs.
  - heat domes/waves and raised water temperatures.
- CC will also alter the timing of flows which are built into the timing of migration and spawning for salmon stocks.

4

WILDFIRE – FURTHER AMPLIFICATION

- The frequency and severity of large, catastrophic wildfires in salmon watersheds are increasing due to Climate Change!
  - 2017, 2018 and 2021 - three worst on record for BC
  - Watershed level impacts (e.g. Bonaparte, Deadman and Nicola)
- Wildfire a compounds climate change impacts by:
  - removing cover (stabilization and shading functions),
  - exposing sediments,
  - altering stream chemistry.
- **Compounding existing CC impacts to stream temperature and the hydrograph!**

5

SOME BETTER NEWS……

- People value watersheds for many reasons: water, fish, recreation, aesthetics, spiritual/cultural etc.
- And our understanding of watershed function and treatments is ever increasing.
- Hopefully some "resets" will bring opportunities.
- People, governments, agencies, industry and NGOs all want to participate.
- Governments are stepping up: resources, FTEs, funding.
- Increasing capacity within First Nations.
- New partnerships and modes of delivery.

6

BUT - RECOVERY IS A COMPLEX PROPOSITION

- Recovery work **will** happen – but many players and many objectives.
- Management of resources in BC has been organized in a siloed manner.
- CC and uncertain end goals - what will we hope for and build towards?
- All levels of government challenged to cooperate (planning and operations).
- Agencies will have to reconcile and align objectives, goals etc.
- Industry and NGOs (e.g. enhancement societies)will have significant roles.

7

CHALLENGES: UNCERTAINTY, TIME, SPACE, AND COMPETING OBJECTIVES

- Watersheds are impacted by weather events in a period of unknowns – climate change and unforeseen events.
- Risks and restoration opportunities are not static - change through time as watersheds recover over decades (e.g. hydrologic recovery).
- Risks, impacts and treatment options are spatial and scale dependent.
- People have complex set of interacting rights, interests, expectations and needs (e.g. Aboriginal Rights, timber harvest/salvage, water use, recreation, access).
- Natural resources and ecosystem services compete for management attention, resources and priority setting within a complex, often siloed, management environment.
- Watershed recovery priorities may change with changing societal values.
- Priority setting and operational delivery requires integration and coordination.
- **Alignment of objectives, resources, talent and organizations is necessary if we are to effectively recover watersheds and inform tradeoff decisions.**

8

A PLAYBOOK TO HELP GUIDE WATERSHED RESTORATION: GENESIS AND

- So much complexity……..“I just wish I had a playbook!”
- PSF proposed “Playbook” to Guide Landscape Recovery Strategies & Priorities for Salmon Habitat Following Major Wildfires in its application to the **BC Salmon Restoration and Innovation Fund.**
  - Funding approved for FY 2021/22.
- Target audience is the forest industry, government agencies, First Nations, NGOs and planning teams.
- The Playbook will provide technical advice and/or recommendations to governments, agencies and all others to use as they see fit.
- The PSF’s goal is to produce a technically and scientifically sound document that would apply to the Pacific Northwest - especially those ecosystems that are at high risk of catastrophic wildfire

9

WHAT WILL THE PLAYBOOK PROVIDE?

- A strategy that will:
  - Generally describe salmon habitat requirements and watershed processes and the impacts (+/-) that wildfires bring.
  - Coalesce, or guide the acquisition of, existing geospatial information, scientific and technical information, assessment and monitoring techniques, policy and BMPs (e.g. treatments/methodologies) and Indigenous Knowledge.
  - Provide priority setting and decision-making support tools.
    - Time and scale dependent treatments set within integrated planning and operational environments (where, when, who, sequencing, alignments, coordination?)
    - Ensconced within:
      - Multi-government (G2G), multi-agency and stakeholder settings that account for different worldviews.
      - Risk management and adaptive management frameworks.

10

PROJECT GOVERNANCE

Management Advisory Committee
- Representation from FLNRORD, Fisheries and Oceans Canada, a First Nation organization and the PSF.
- High level guidance on scope, program alignment etc.

Working Group
- Representation from FLNRORD, Fisheries and Oceans, First Nations and the PSF (perhaps others).
- Will guide the consultant team in the preparation of the Playbook.
- Environmental Dynamics Incorporated, has been contracted to prepare the Playbook and associated Information Catalog and Communications slide-deck.

Advisory Body
- Approximately 30-50 individuals with expertise in fish habitat, hydrology/geology, forest operations, integrated and G2G planning, IT and IK.
- Representation sought from FLNRORD, MoECCS, Fisheries and Oceans, First Nations organizations, academia, industry, NGO, and the PSF.
- Review function which will feed up to the Working Group.

11

PROJECT TIMELINES

- Delivery of Workshop to build awareness, community and raise profile of project - January 26
- Finalize all three levels of governance and activate them – early February
- First draft of a Catalog for distribution to Advisory Committee – mid February
- Develop the Playbook through the Last Quarter of the 2021/22 FY
- Complete input and review processes by the end of the First Quarter of the 2022/23 FY
- Finalize the Playbook **(1st Edition)** and associated products by the end of the First Quarter of the 2022/23 FY

12

A CALL FOR PARTICIPATION

- Membership on the Advisory Body has not been established yet. As stated This group should involve representation from First Nations, DFO, FLNRORD, MAGG, MoECC, NGOs, Industry and the PSF.
- Please consider becoming involved in the Playbook project……a diversity of perspectives, experience and expertise is required.

Contact: Jeff Morgan
Phone: (250) 318-5666
Email: jeffmorganfw@gmail.com

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THANK YOU!

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