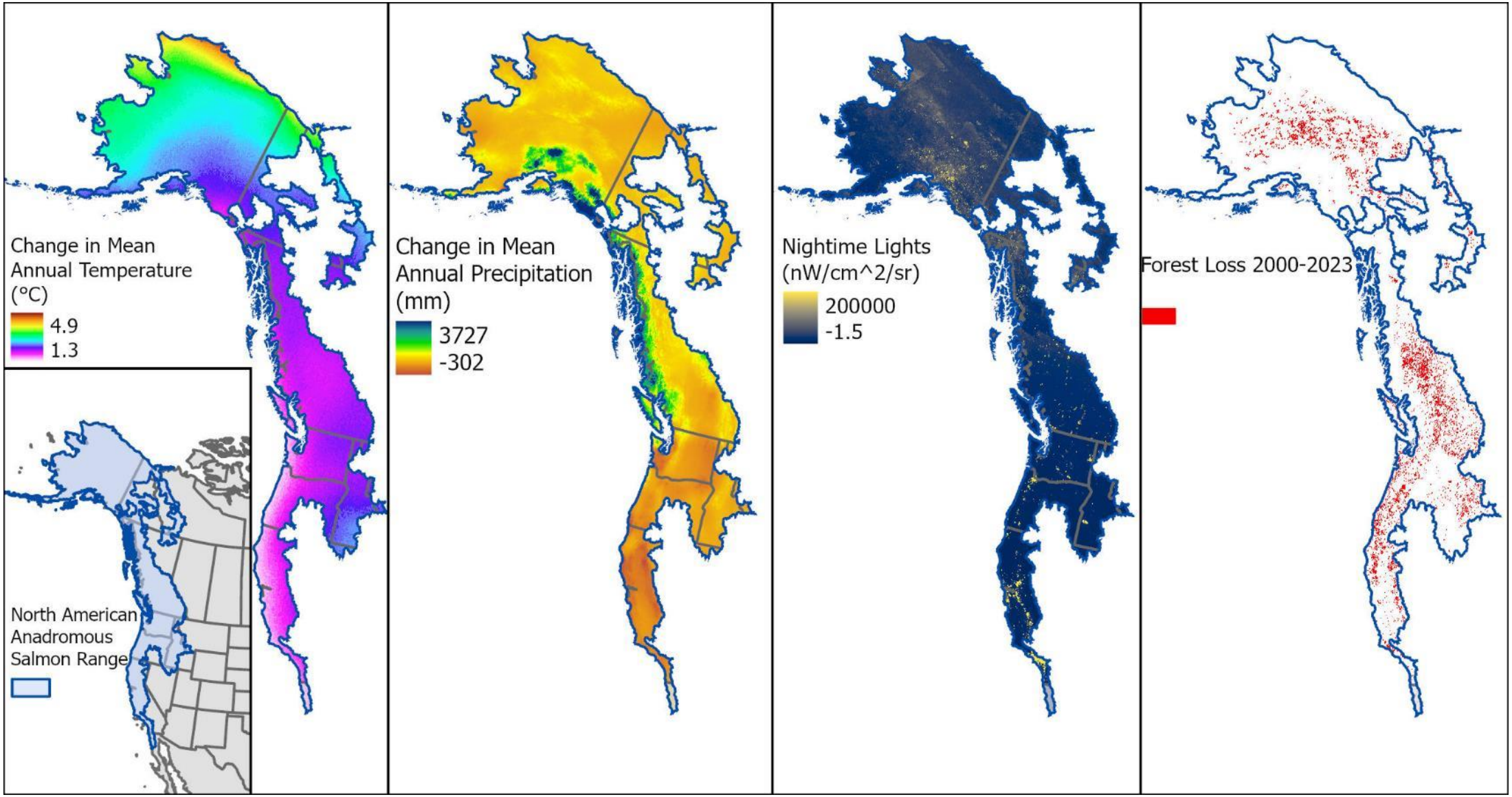
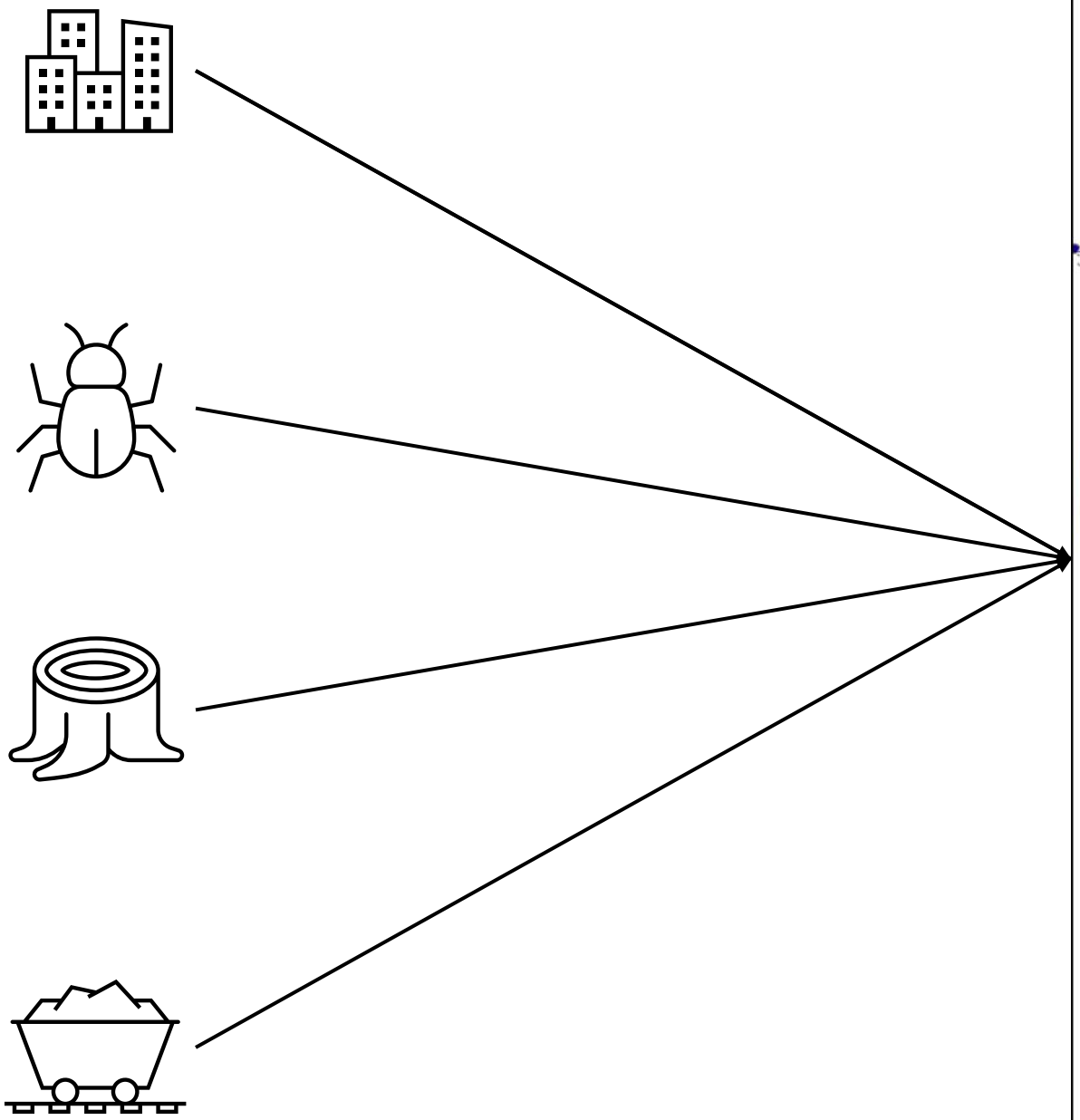
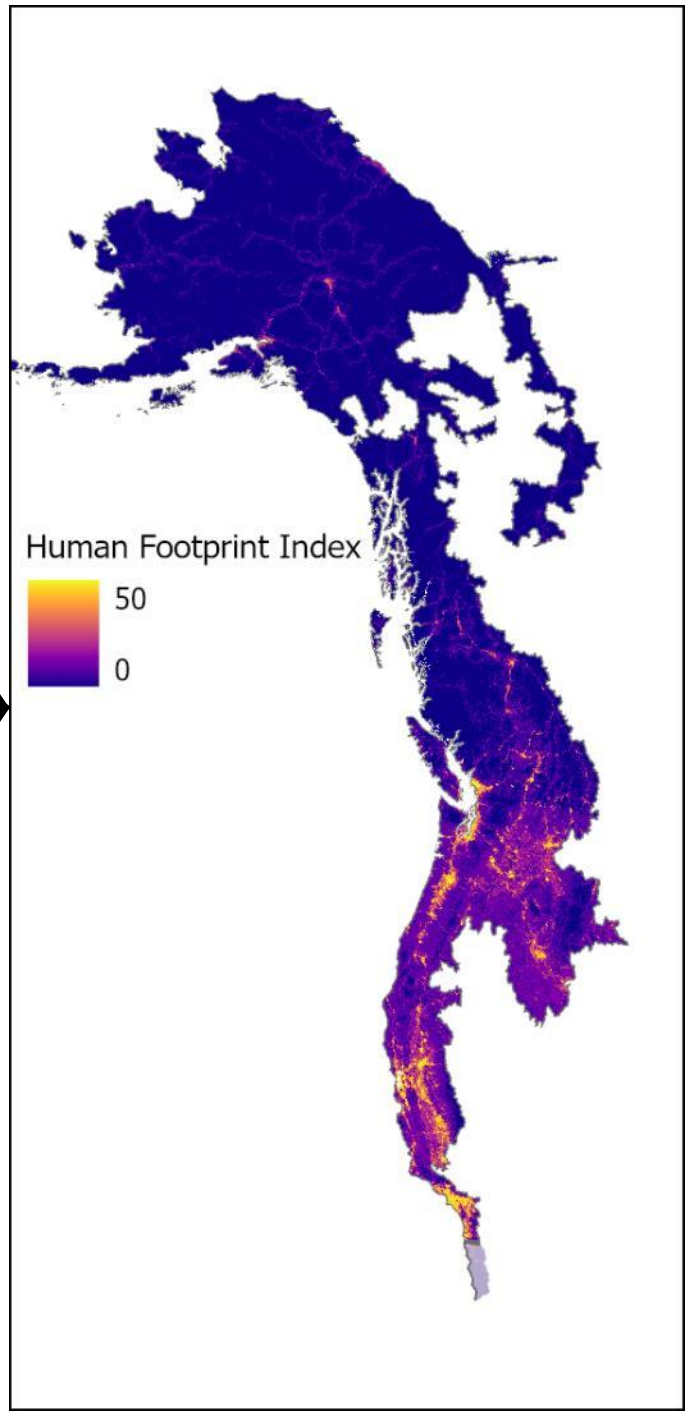

Spatial Patterns in Cumulative Impacts


Cumulative effects are “a wicked problem”


Change in Mean
Annual Temperature
(°C)
4.9
1.3
North American
Anadromous
Salmon Range
Change in Mean
Annual Precipitation
(mm)
3727
-302
Nightime Lights
(nW/cm^2/sr)
200000
-1.5
Forest Loss 2000-2023




Human Footprint Index
50
0

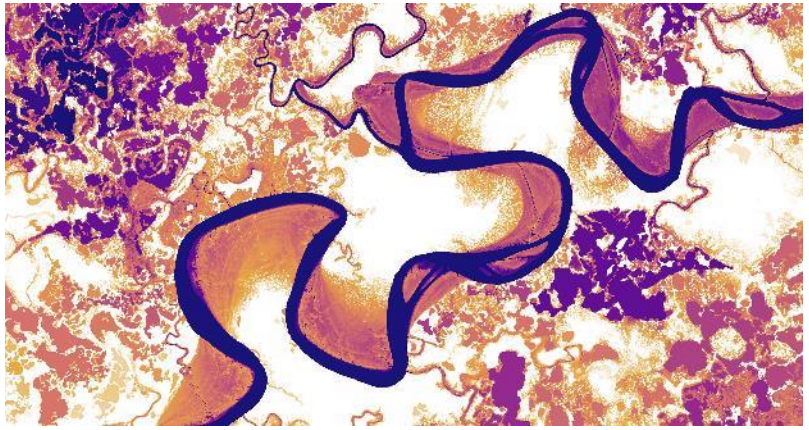
Instead of asking how much pressure exists, we are looking to see whether distinct pressure combinations occur repeatedly across landscapes.

1. How are cumulative pressures distributed across BC Salmon Watersheds?

2. Are there any recuring patterns of pressures?

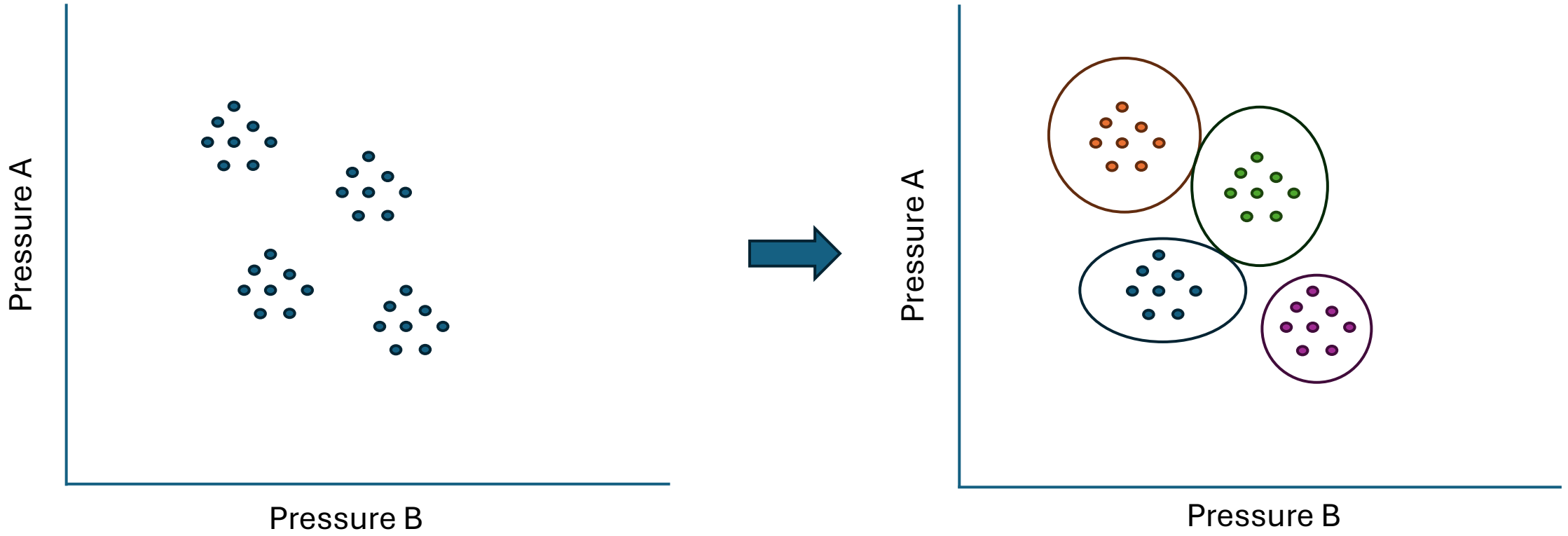
3. How are these stressor clusters associated with different salmon species and their conservation status?

Study Area and Data

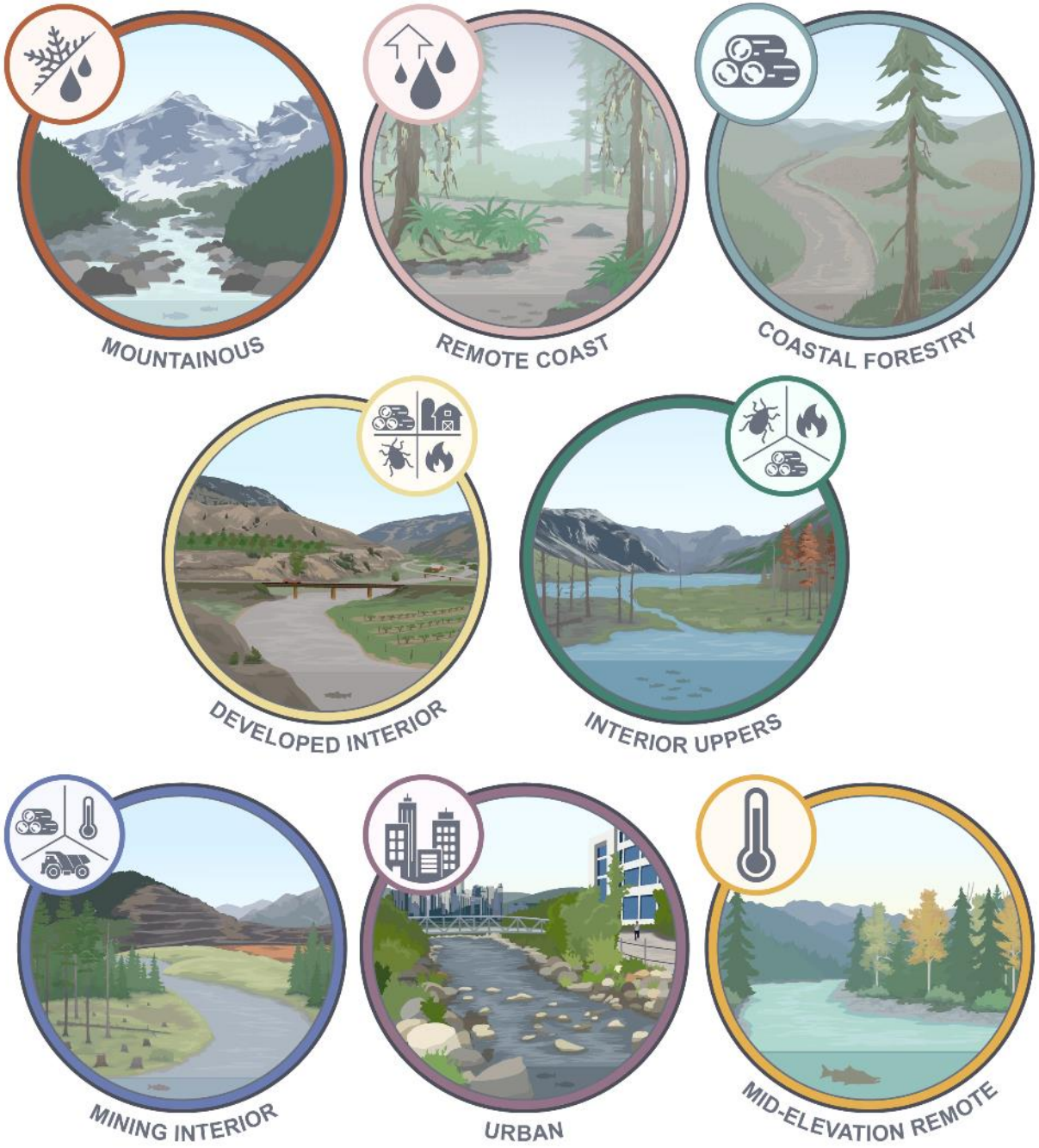


Pressure Indicator Data

Clustering Methods (K-means)



8 distinct pressure archetypes



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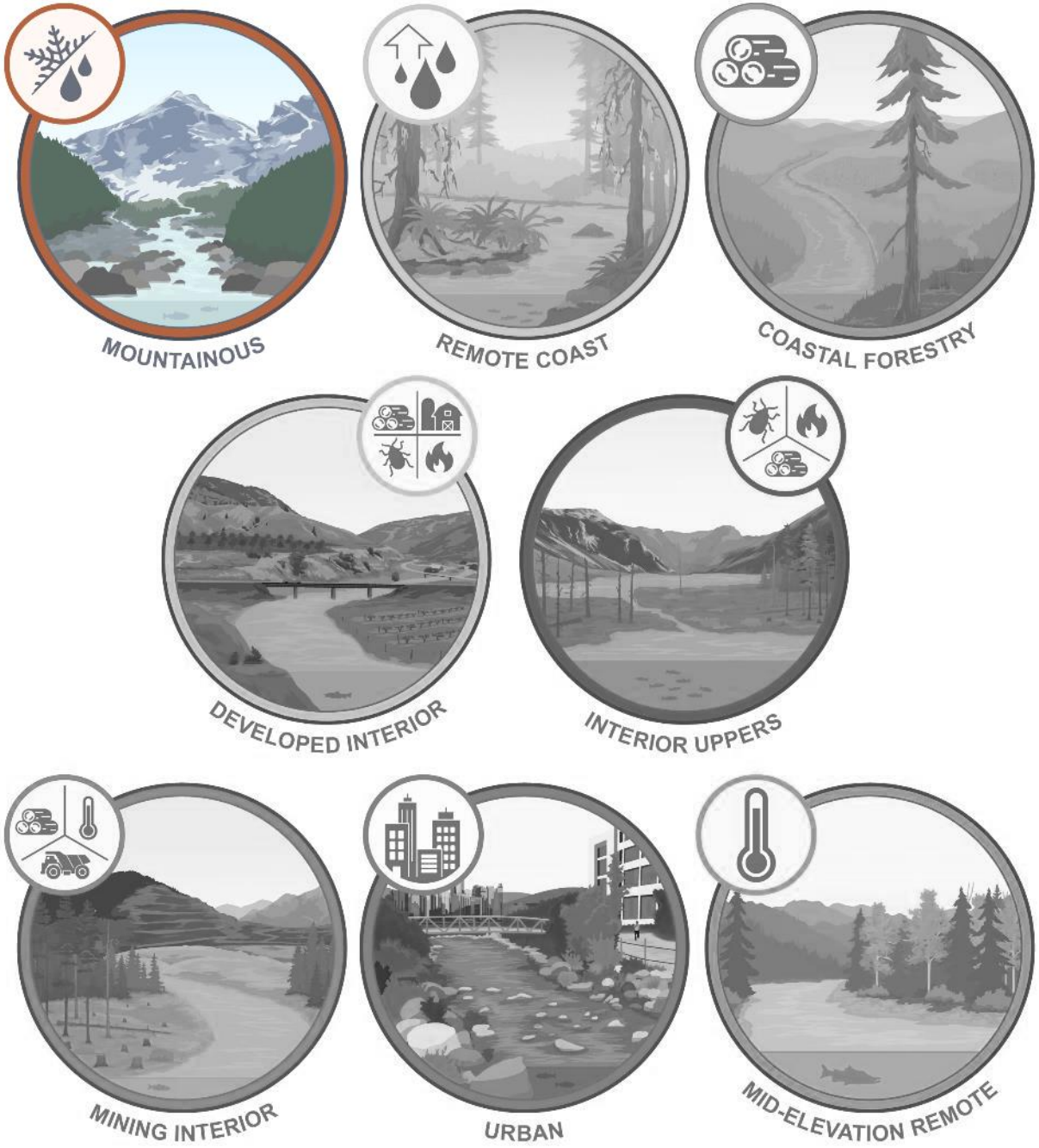
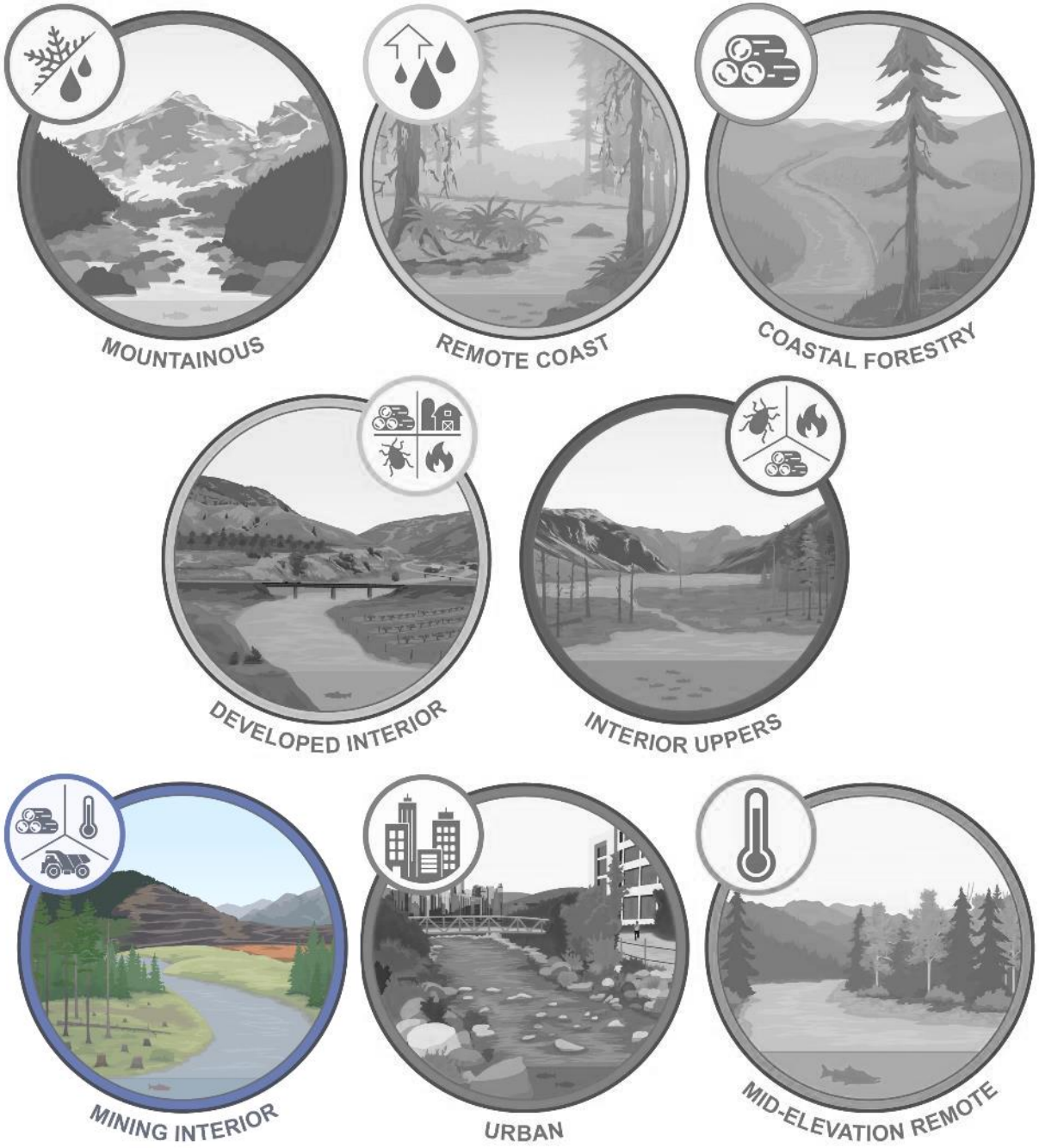
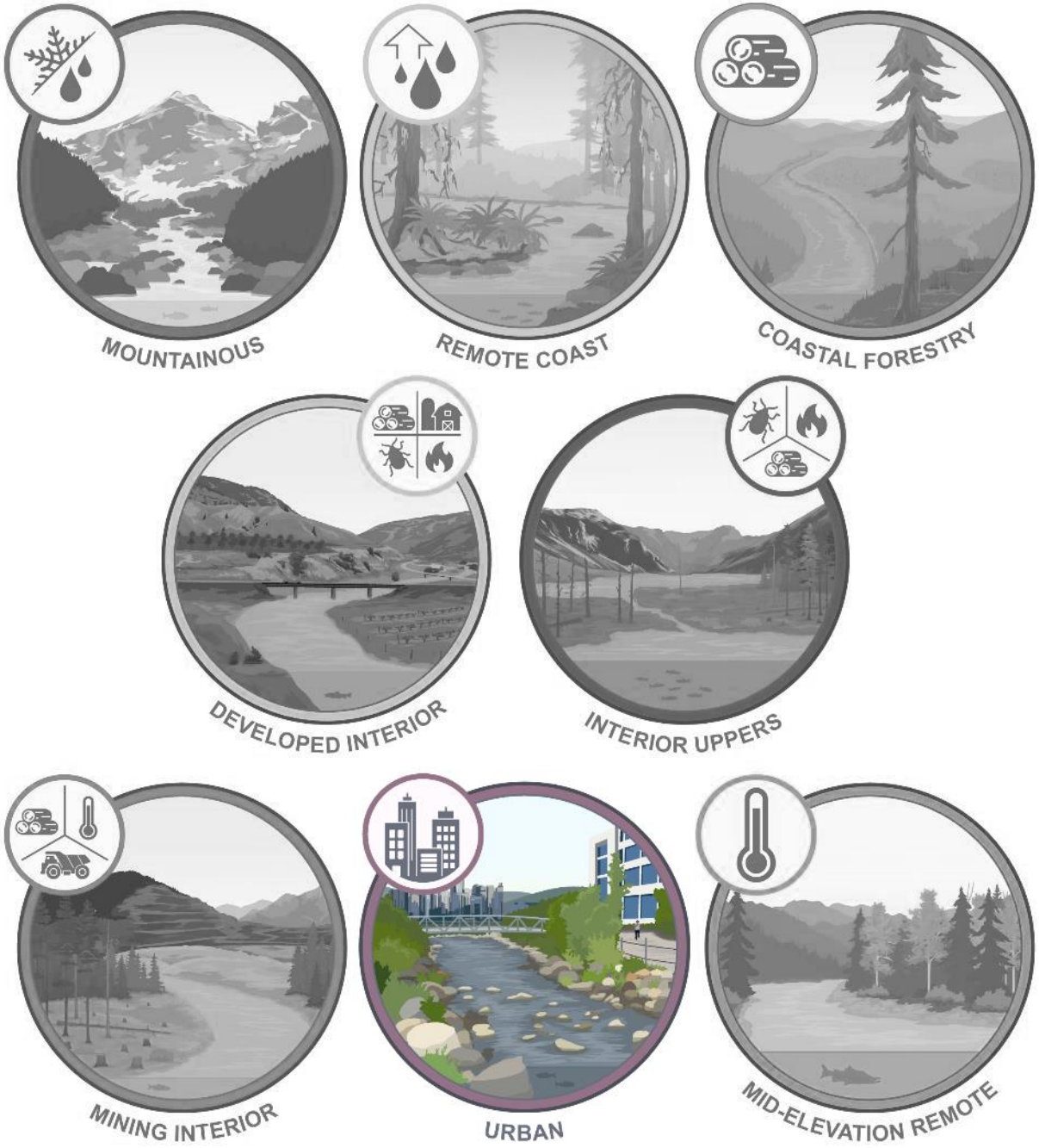
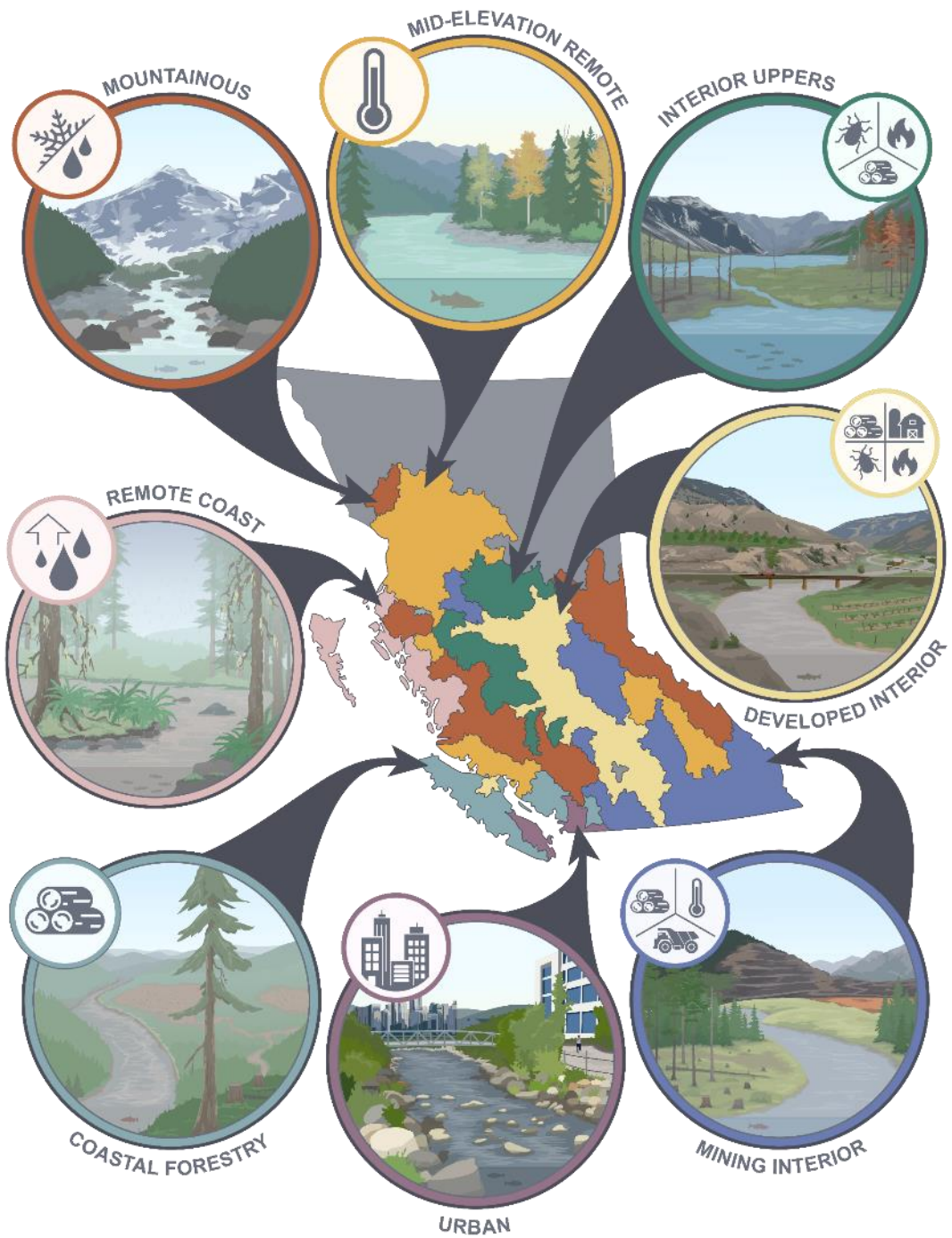


8 distinct pressure archetypes



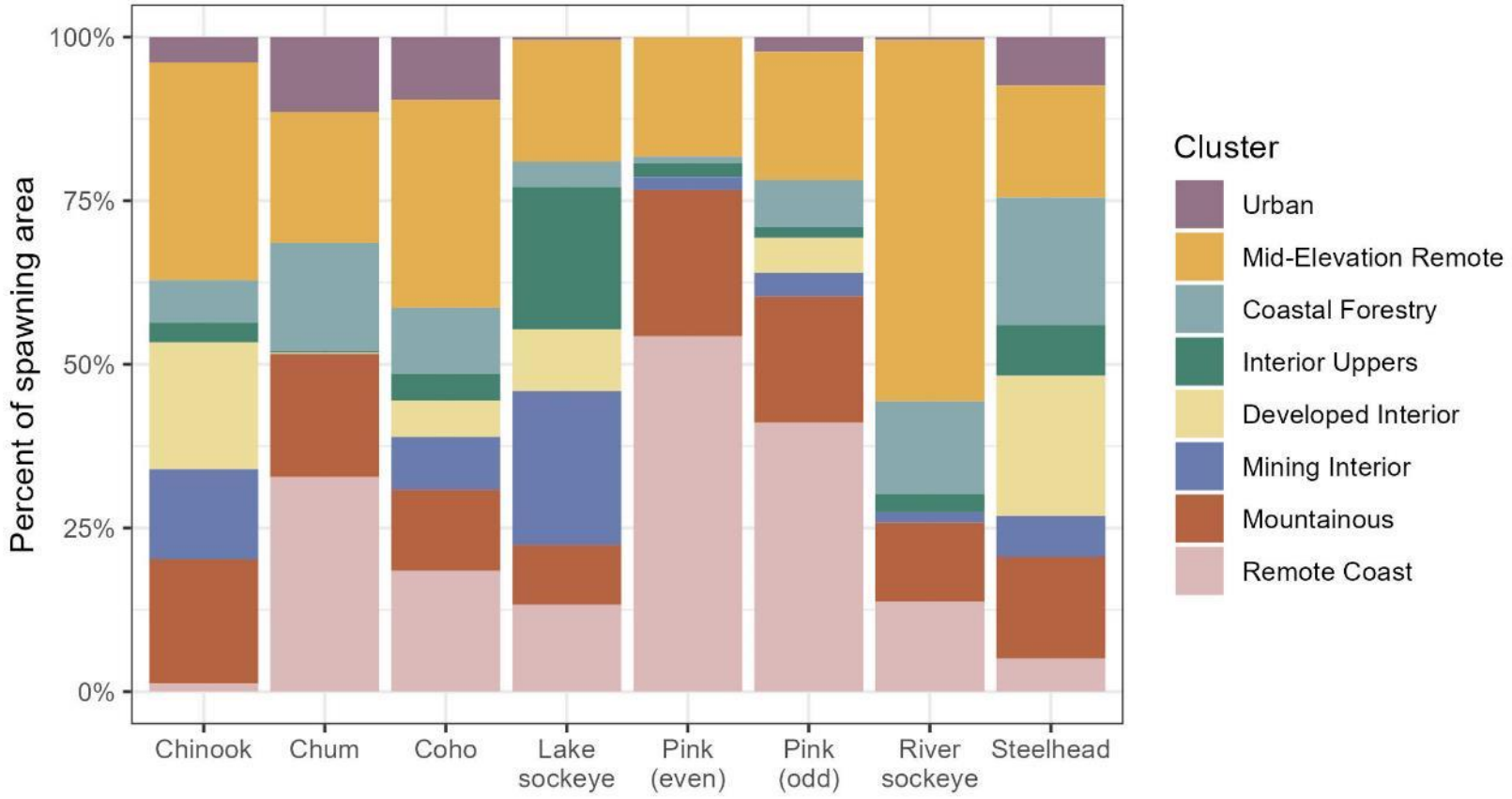
8 distinct pressure archetypes



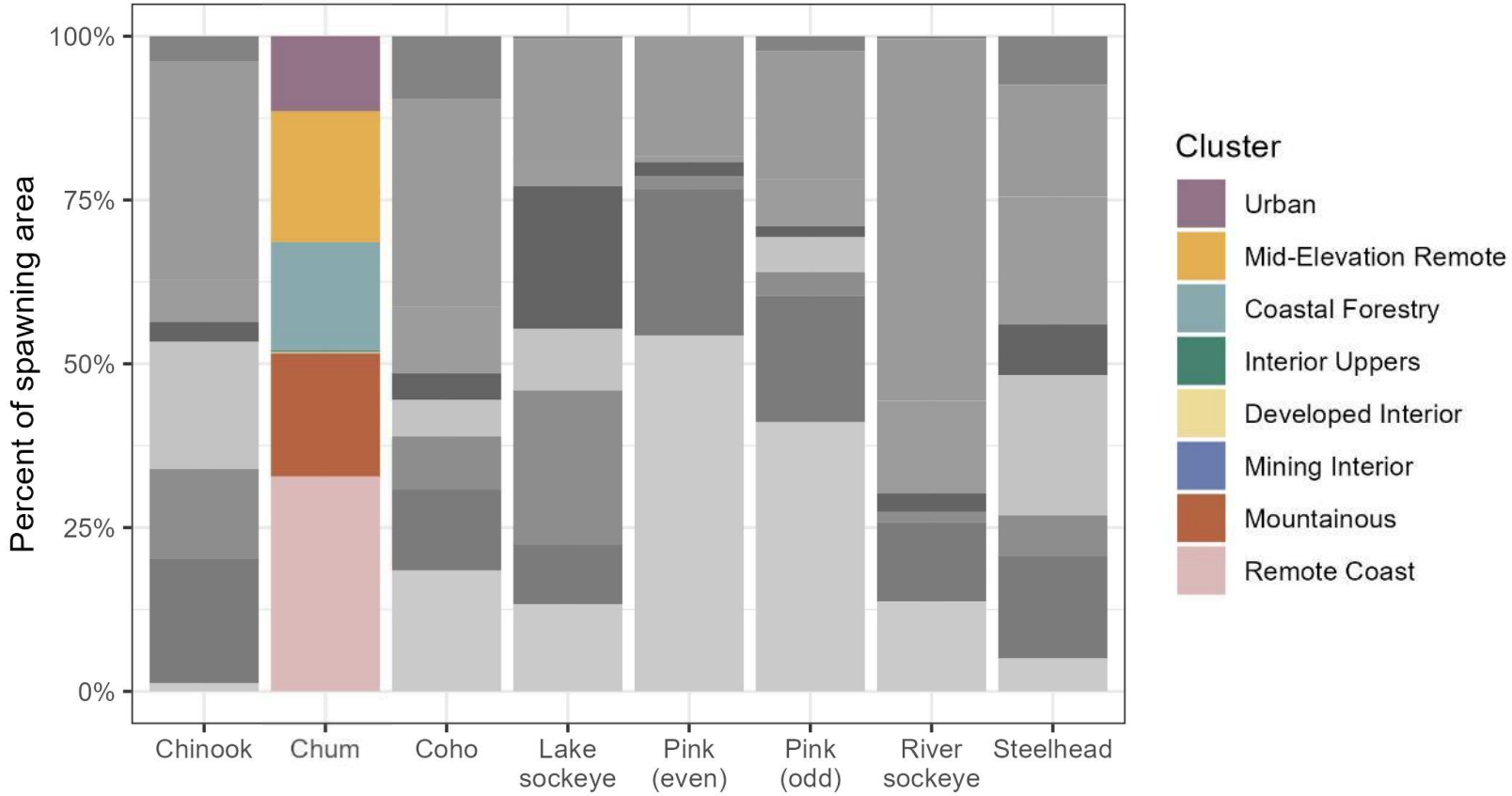


Spawning habitat

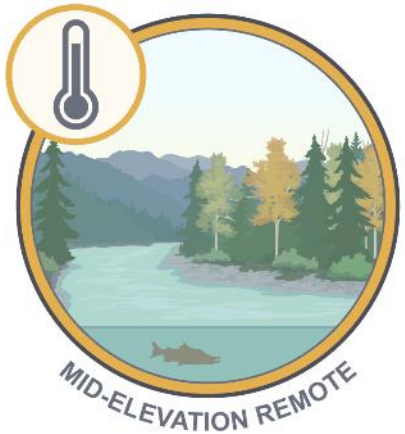
Varying exposure to pressure by species

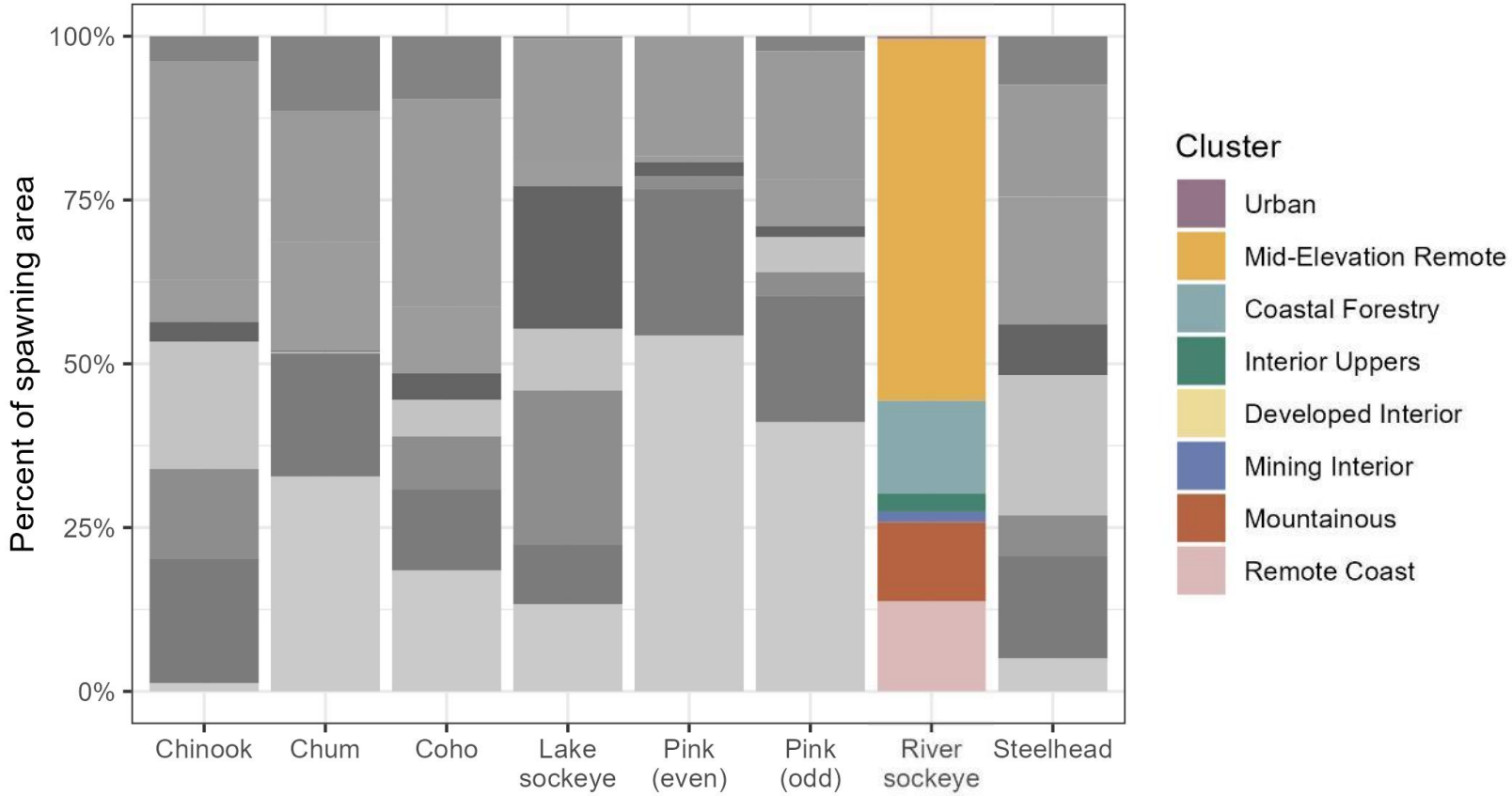


Chum salmon spawning



River type Sockeye





Different pressure bundles likely require different management responses

Archetype		Potential Priority Actions
Urban	→	Barrier removal, culverts
Coastal Forestry	→	Riparian protection
Mining Interior	→	Mine risk mitigation
Remote Coast	→	Climate adaptation
Developed Interior	→	Restoration and connectivity

Conclusions

- Presented a novel approach to distill enormous complexity
- Particularly useful in data limited systems
- If pressures are clustered, solutions are clustered.

Thanks!

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Salmon Watersheds Lab

WATERSHED FUTURES
INITIATIVE

SFU SIMON FRASER UNIVERSITY

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RESEARCH ARTICLE

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Salmon watershed archetypes: A clustering of cumulative pressures and climate change

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Abstract

1. Cumulative effects of land-use change and climate change are leading to biodiversity decline globally. Spatial analyses of cumulative pressures that distill complexity and provide actionable information for the management of cumulative pressures on vulnerable species are needed. For example, many populations of Pacific salmon are struggling across their vast range because of their exposure to myriad land-use and climate change symptoms. Understanding the spatial distribution of cumulative pressures is of importance for policy makers, watershed, fisheries and conservation managers to identify pathways forward for the diverse set of challenges facing salmon.
2. We characterize the spatial patterns of multiple cumulative effect pressures, examine pressure co-occurrence and observe how the spatial distribution and co-occurrence of cumulative effect pressures links to salmon population status and overlaps with spawning habitats. To do so, we used 17 indicator variables representing forest disturbances, urbanization, mining, local geography and climate change in a k-means unsupervised classification algorithm.
3. Our results show eight distinct watershed archetypes (urban, mid-elevation re-