Spatial-temporal changes in kelp extent in the Gulf Islands and Southern Vancouver Island: a remote sensing approach

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Salish Sea conference, 26-28 April 2022

We acknowledge and respect the lək̓ʷəŋən peoples on whose traditional territory the university of Victoria stands and the Songhees, Esquimalt and SENĆOŦEN speaking people, the *W̱SÁNEĆ nations whose historical relationships with the land continue to this day. Additionally, our work take us all across the coast and we acknowledge with respect the many ongoing relationship the multiple nations have with the land and ocean along the coast of British Columbia.*

NSERC Alliance Grants

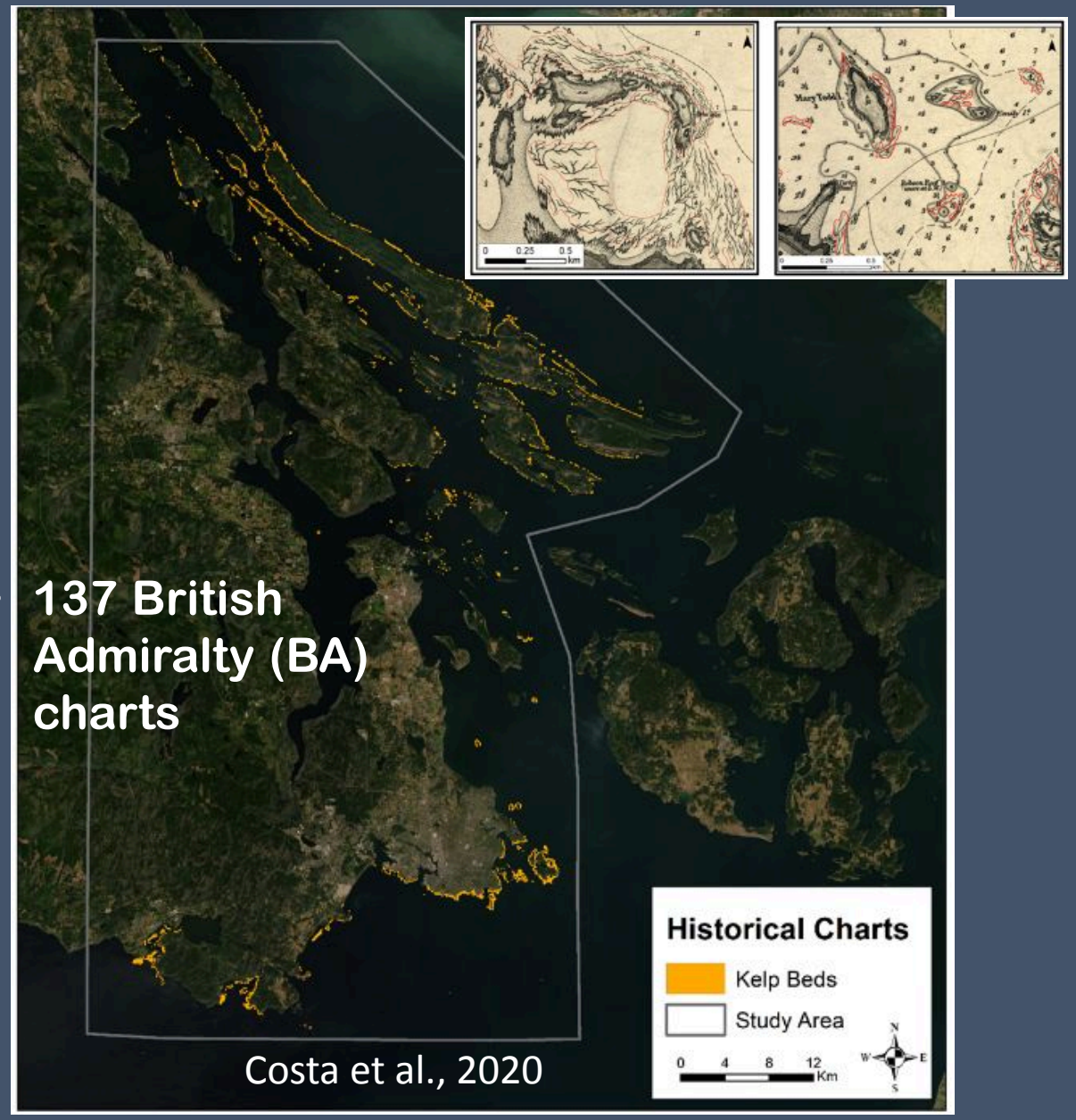
Background and objectives

Goal:

To determine the long-term spatial-temporal resilience of canopy-forming kelps, in response to local and regional environmental drivers along the coastlines of the Southern Vancouver Island and the Gulf Islands.

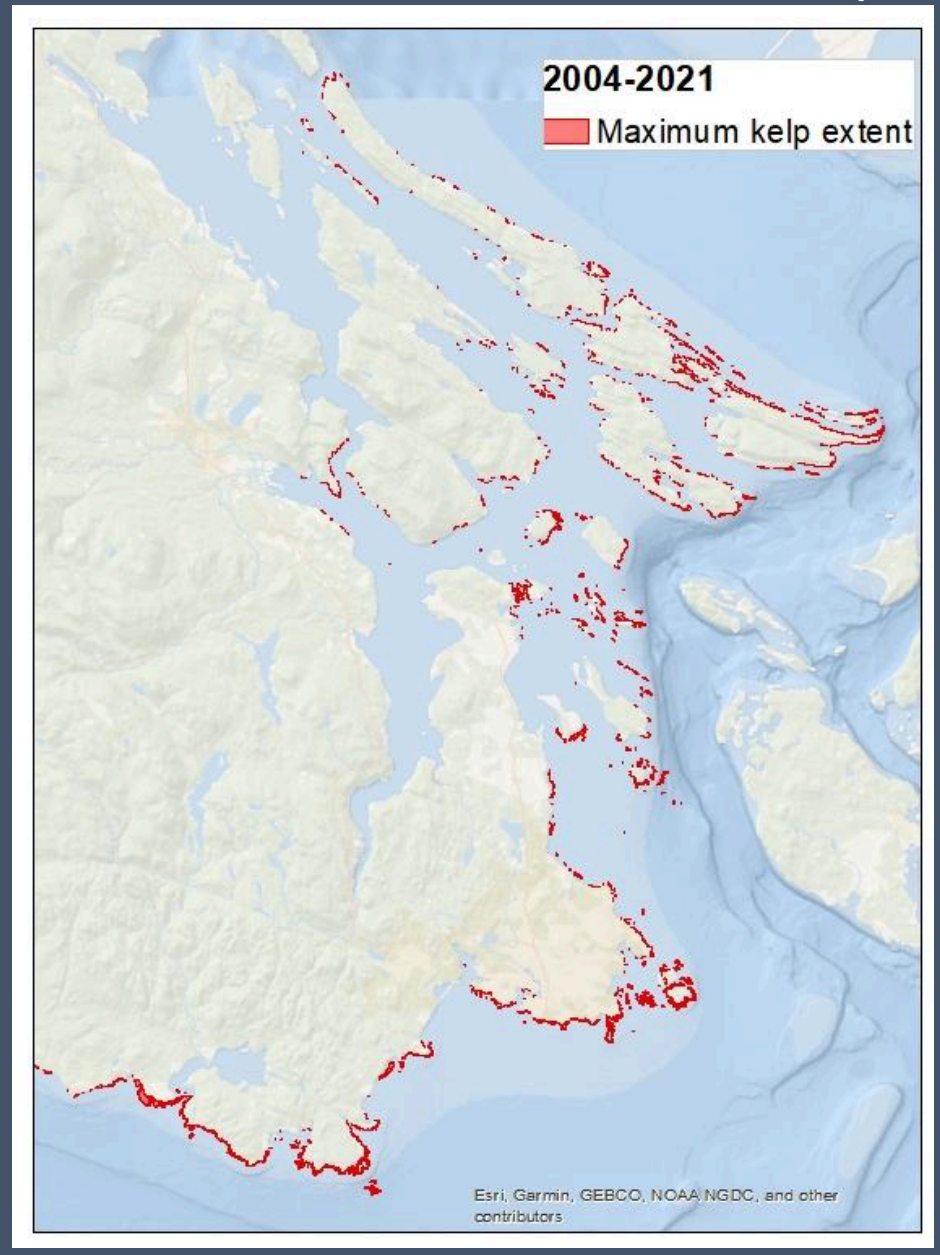
Photo: Lianna Gendall

Historical - 1850s



- 137 British Admiralty (BA) charts

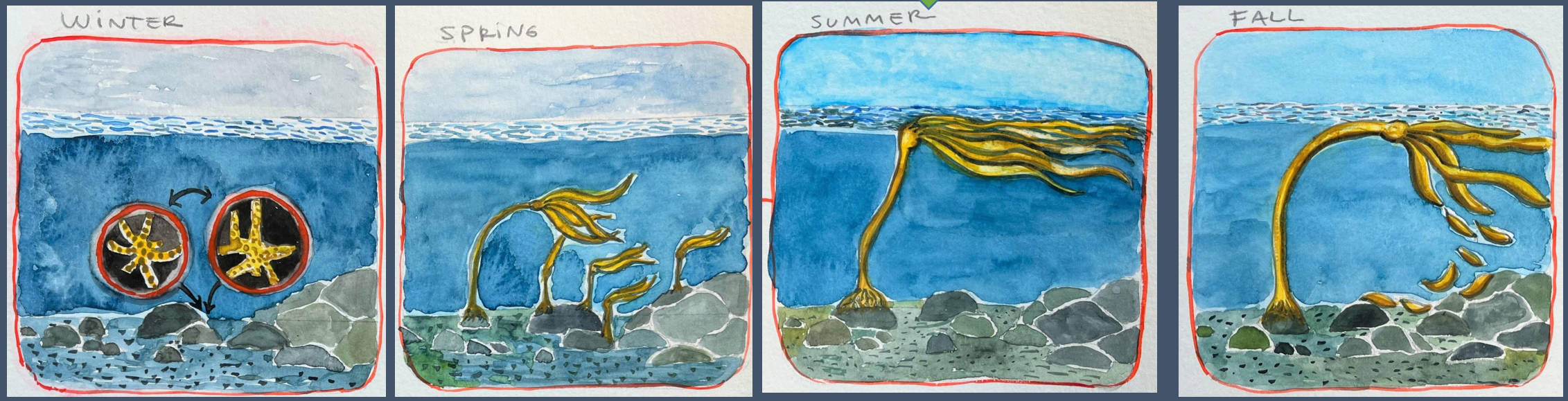
2004-2021 - maximum kelp extent



Concepts

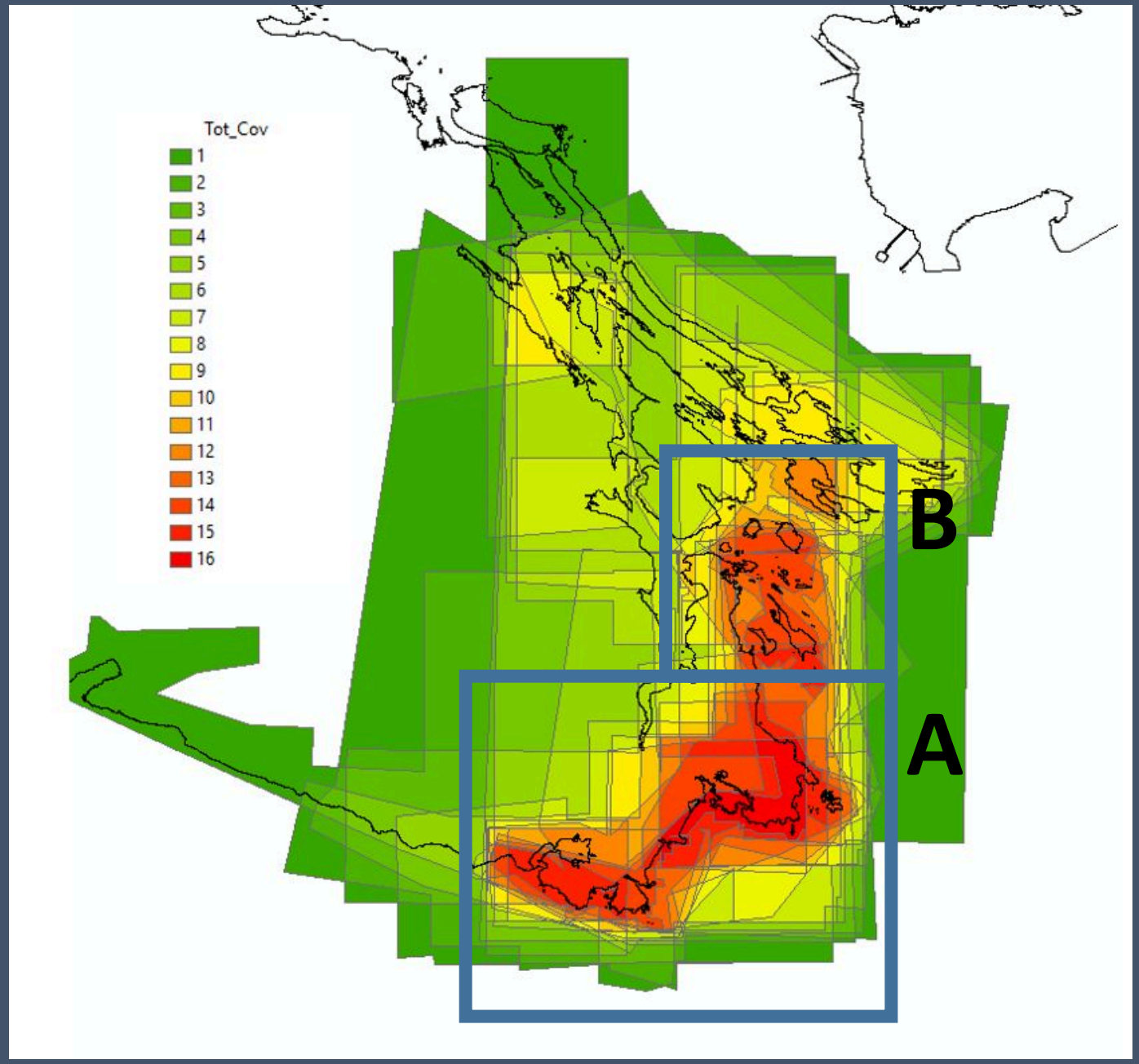
- Resilience
- Vulnerability

Kelp Niche-
Nereocystis luetkeana



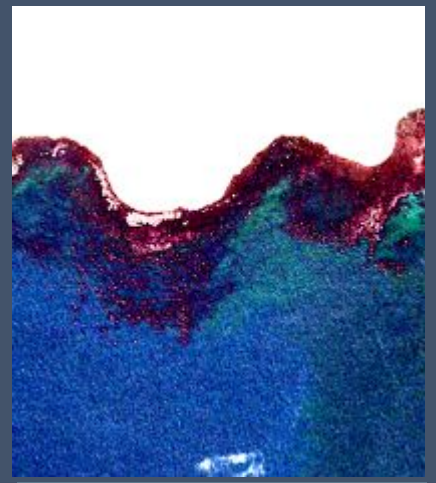
Methodology: Kelp detection with high-res imagery

High-res aerial photography
World View 2-3
Spot 6
Planet
Rapid Eye
Kompsat



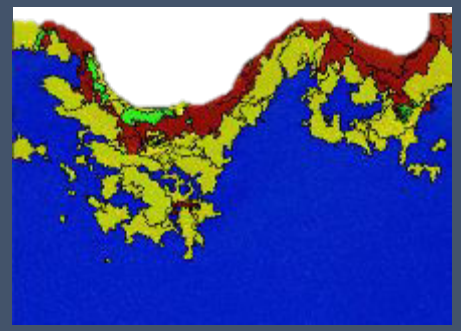
Methodology: Kelp detection with high-res imagery

Mask
Deep Water,
Land and
Soft Substrate



Atmospheric
Correction
or Histogram
Shift

Band Indices
(NDVI, GNDVI,
Re/Y)
+
Stretch Input
Bands



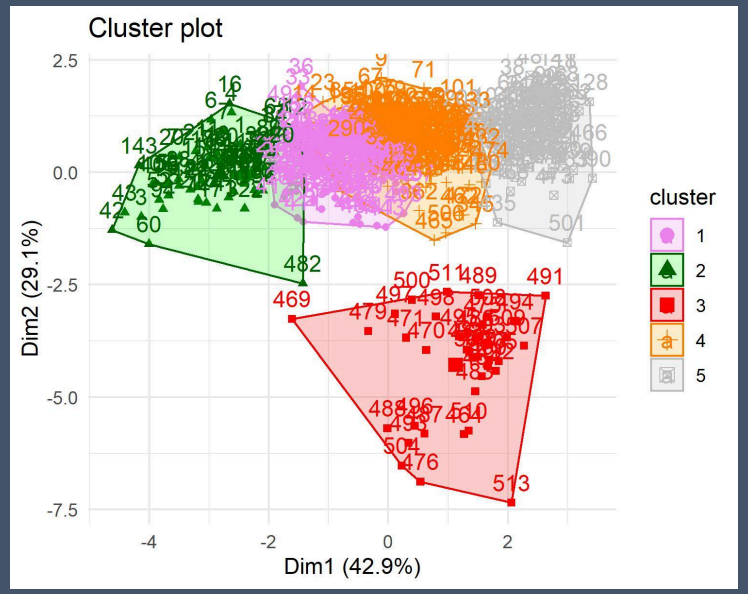
Object Based
Segmentation
+
Nearest Neighbor
Classification

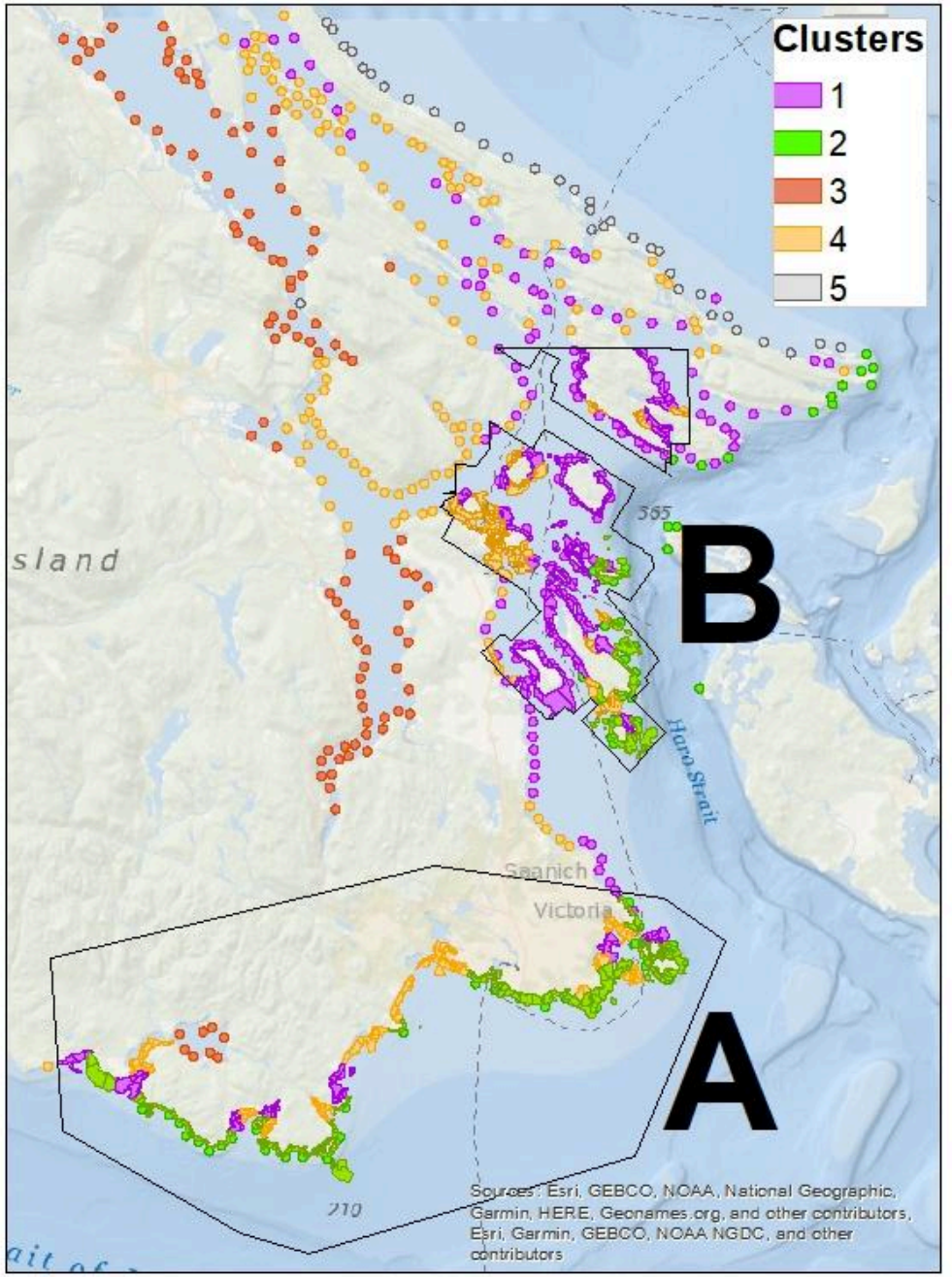
Validation

TIME SERIES ANALYSIS

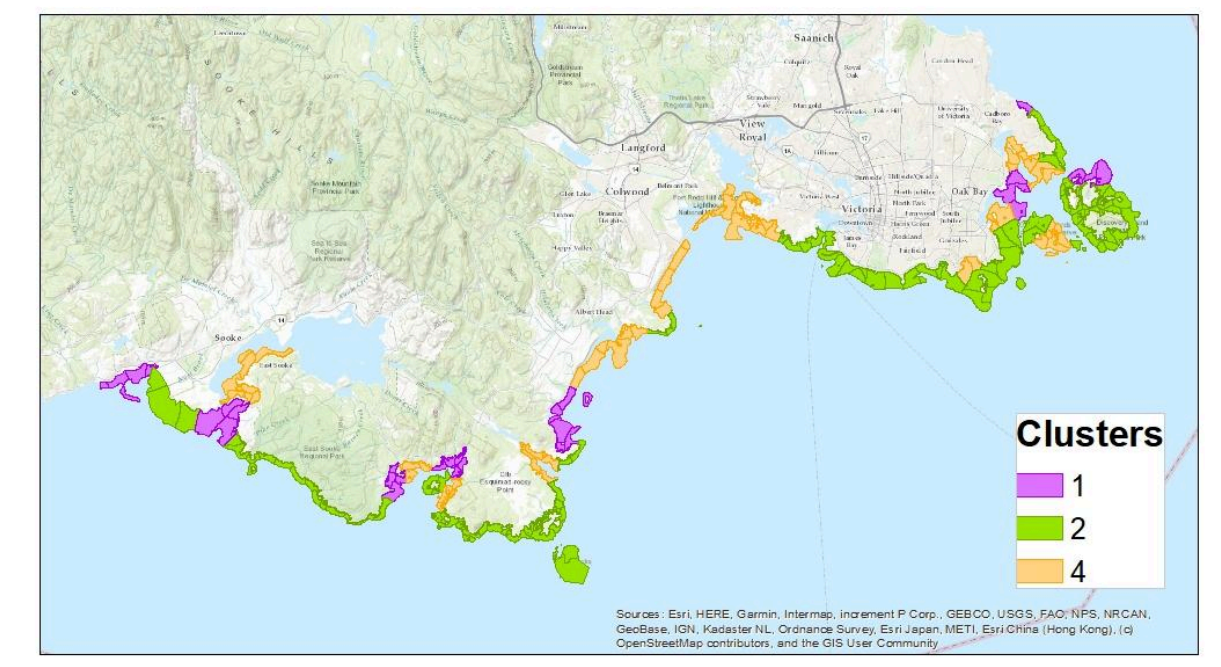
Cluster analysis

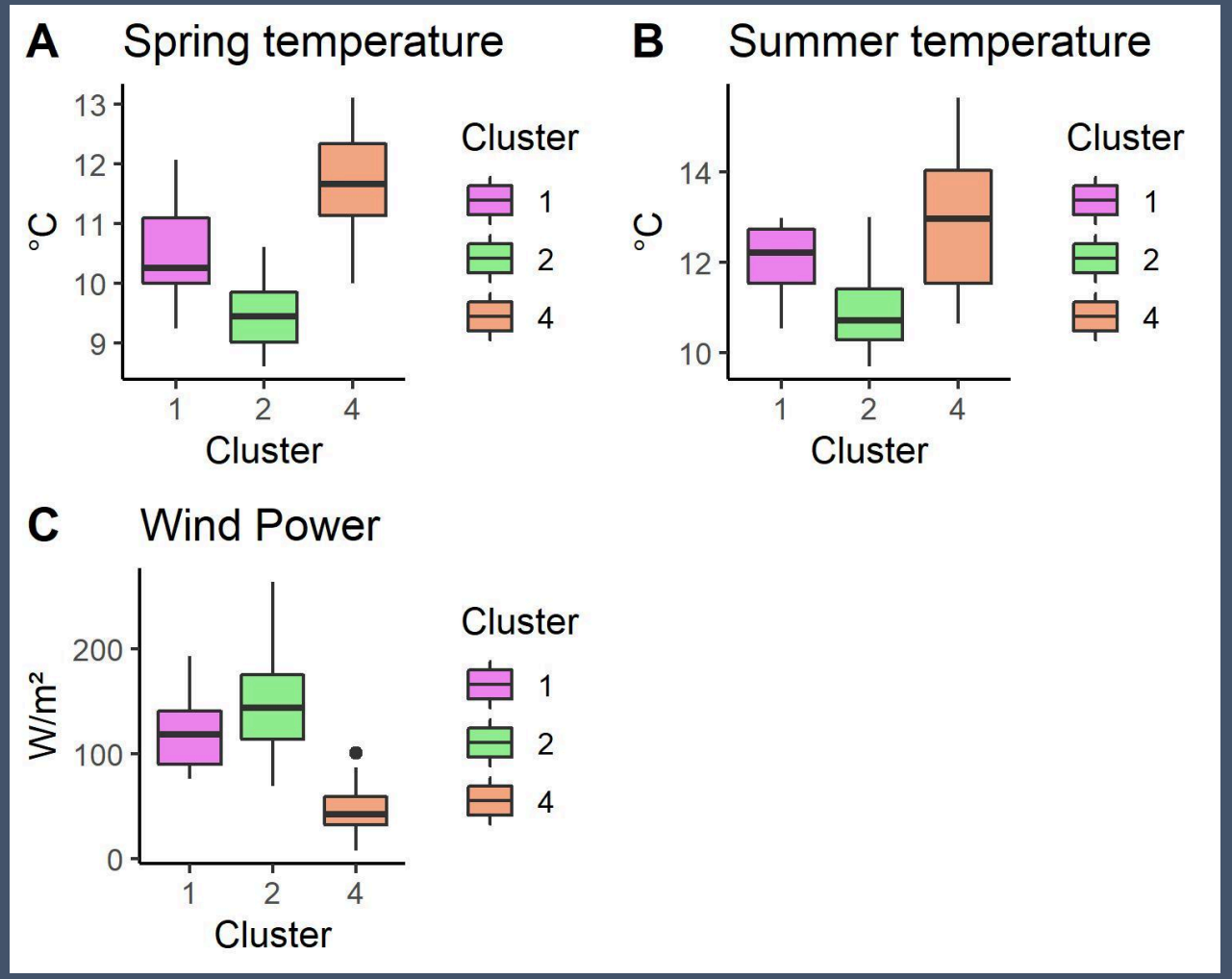
- Wind Density (W/m)
- Landsat- derived Thermal Infrared SST (°C) Spring-Summer
- Fetch (m)
- Tidal Amplitude (m/s)
- Total Suspended Matter (Mg/L) Spring- Summer



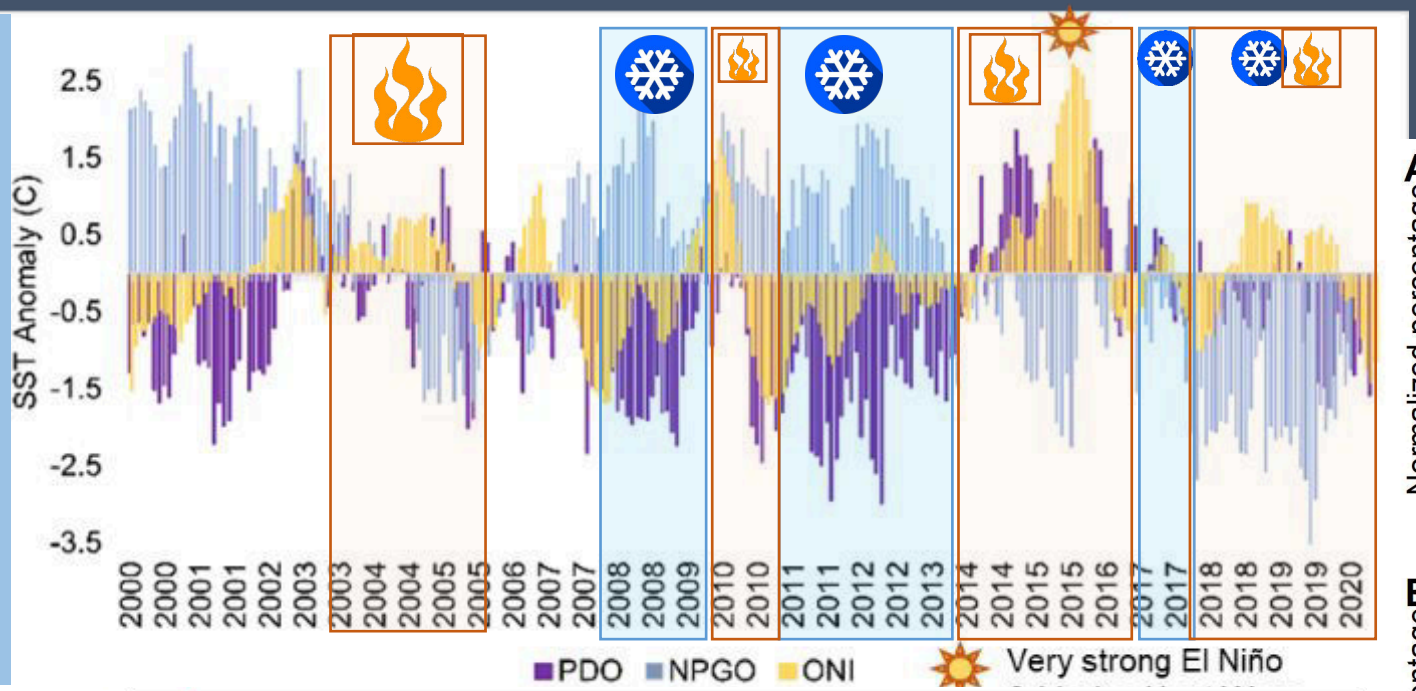


A. Victoria- Sooke

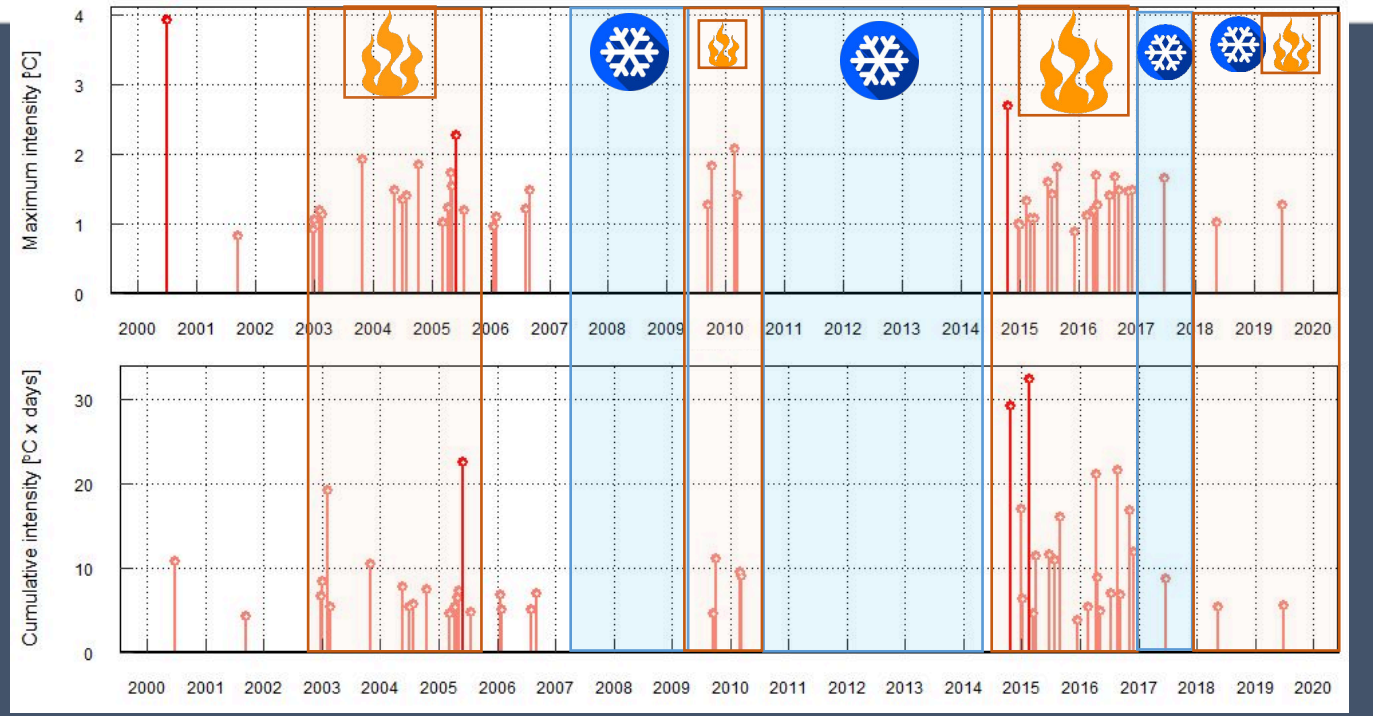




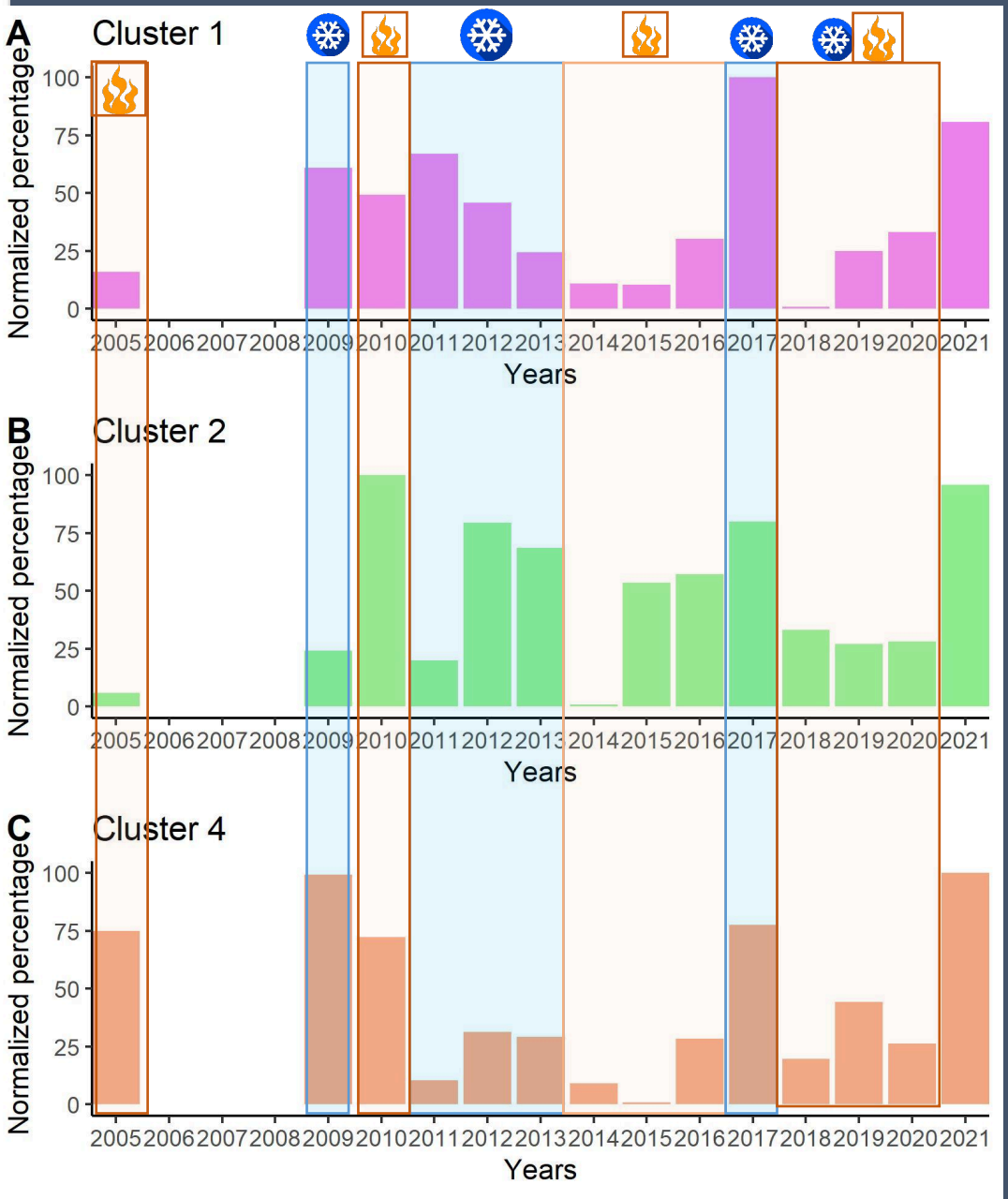
Oceanic Oscillations



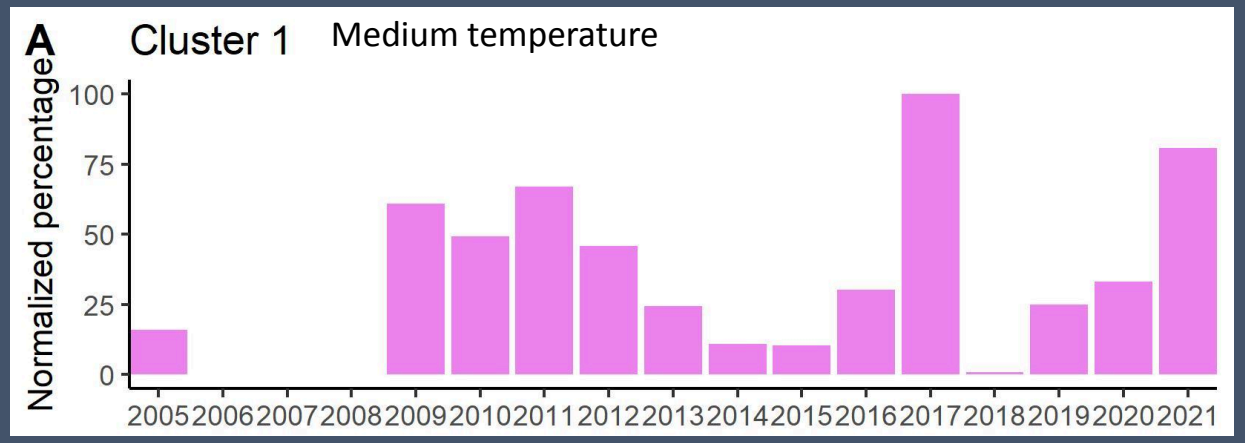
Marine heatwaves

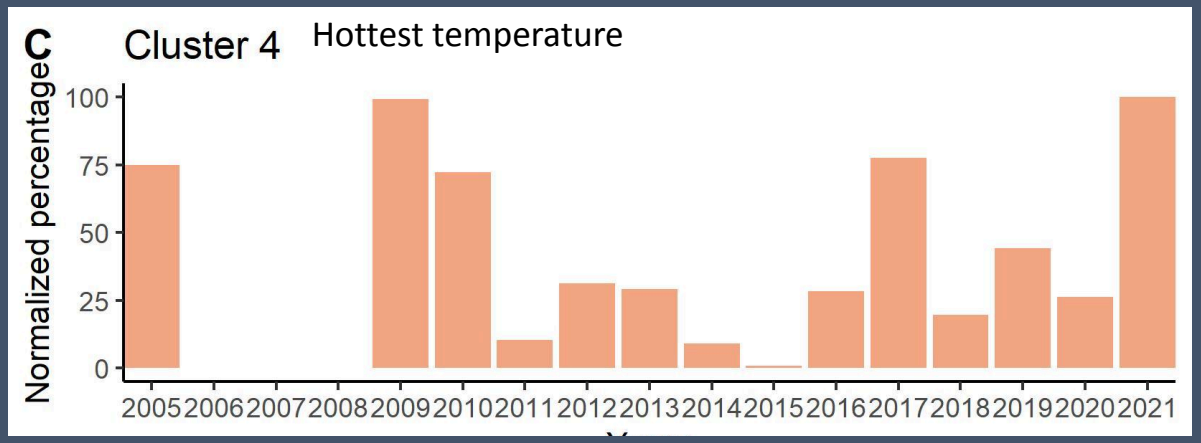


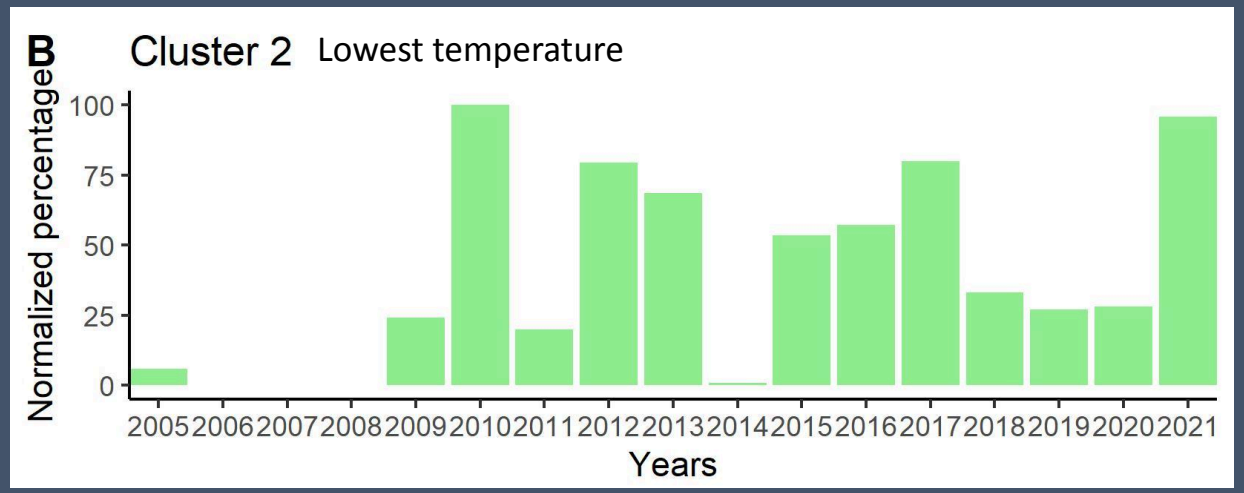
Kelp extent per cluster

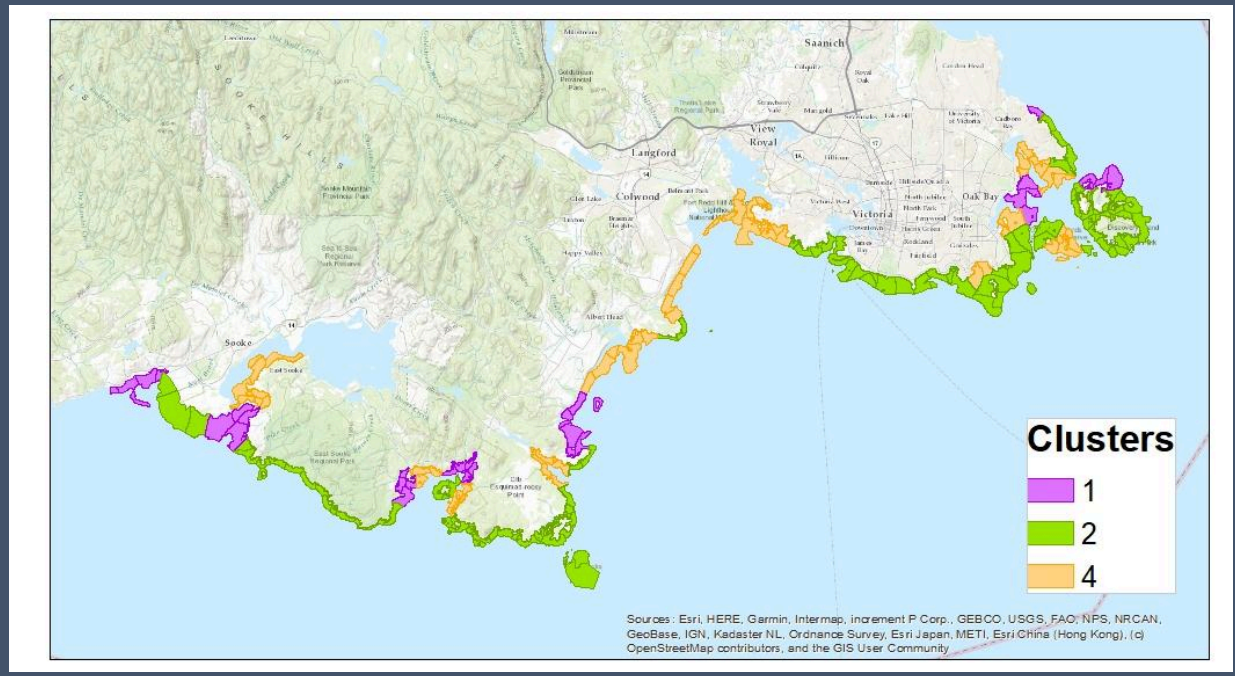


Kelp extent per cluster

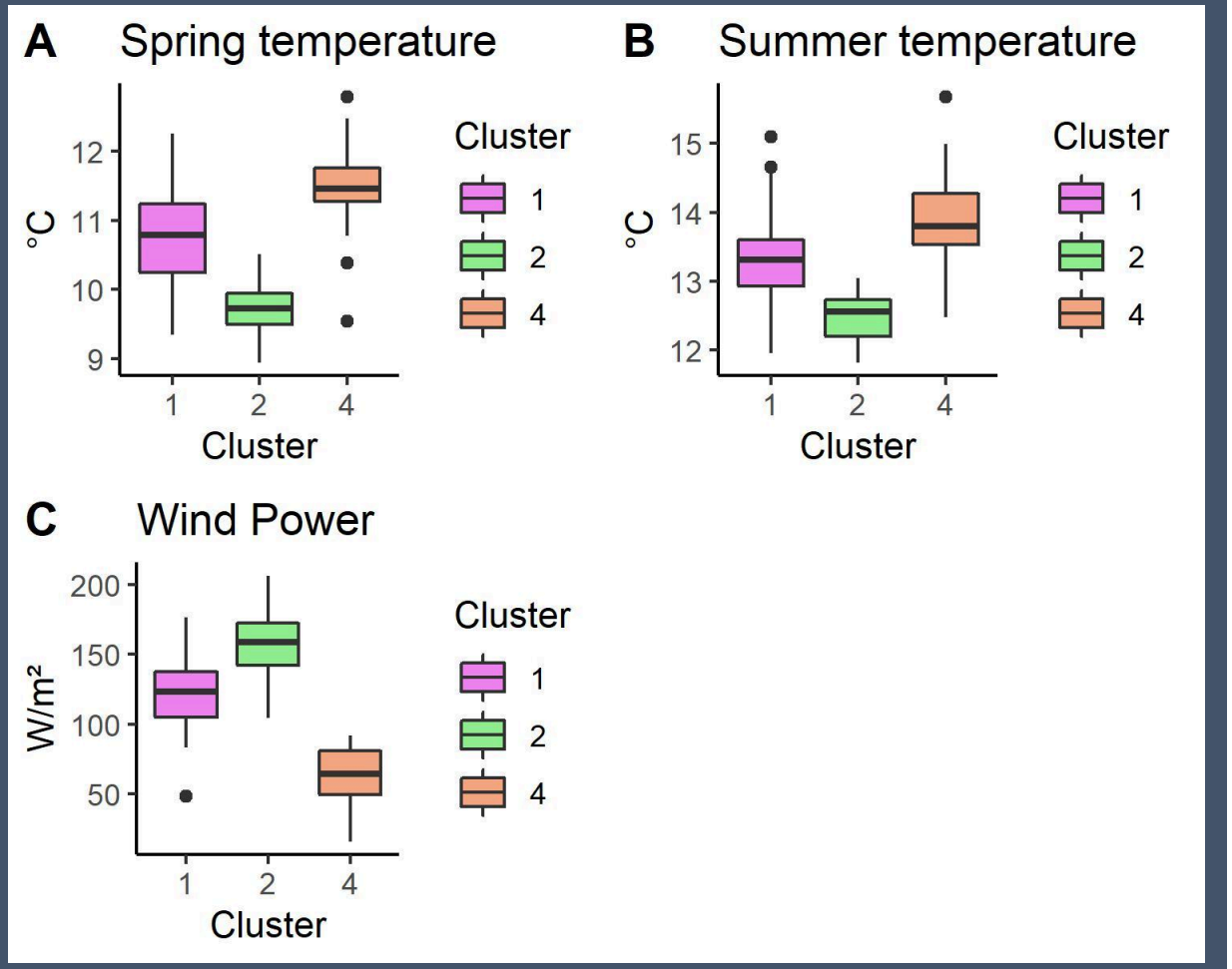


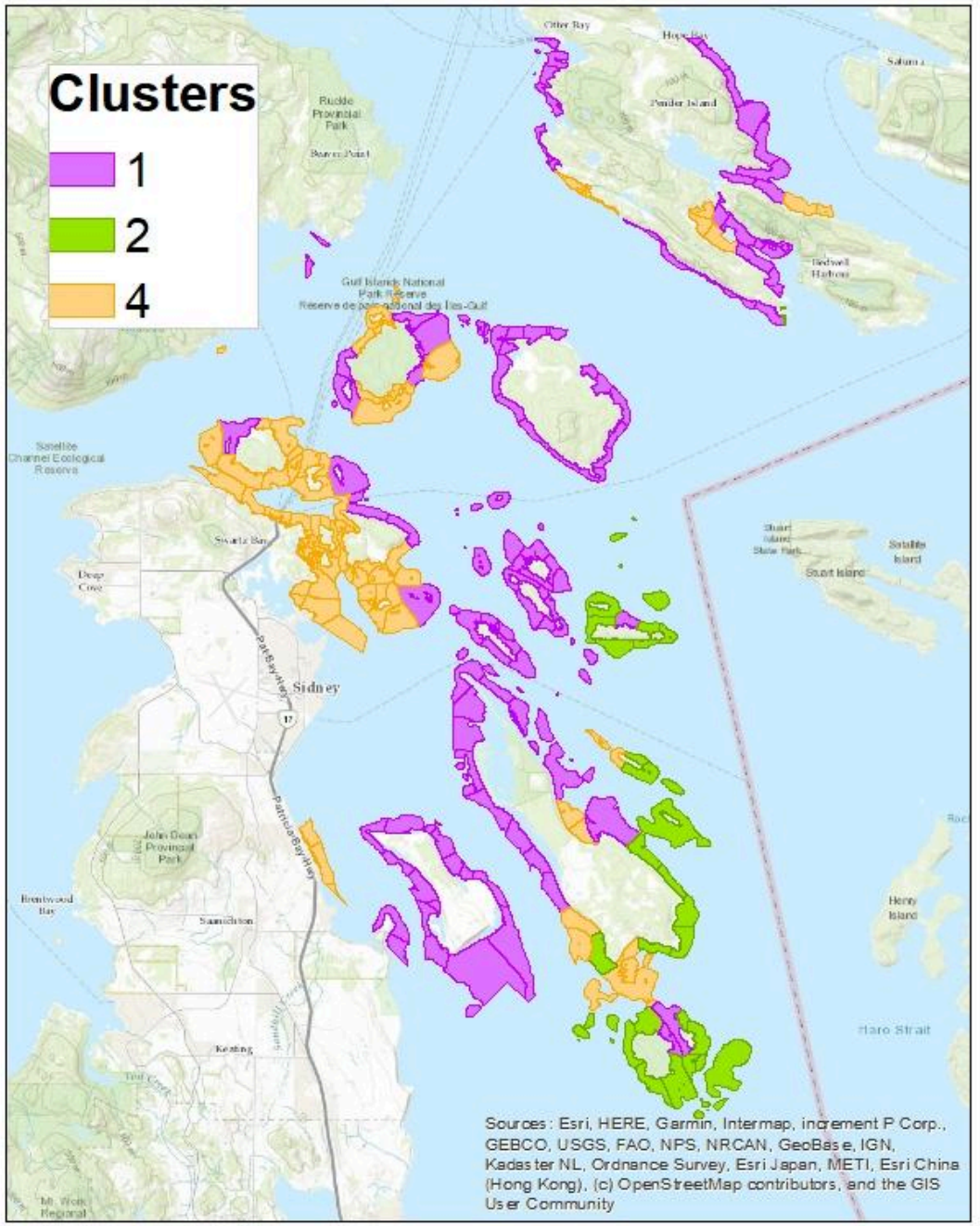




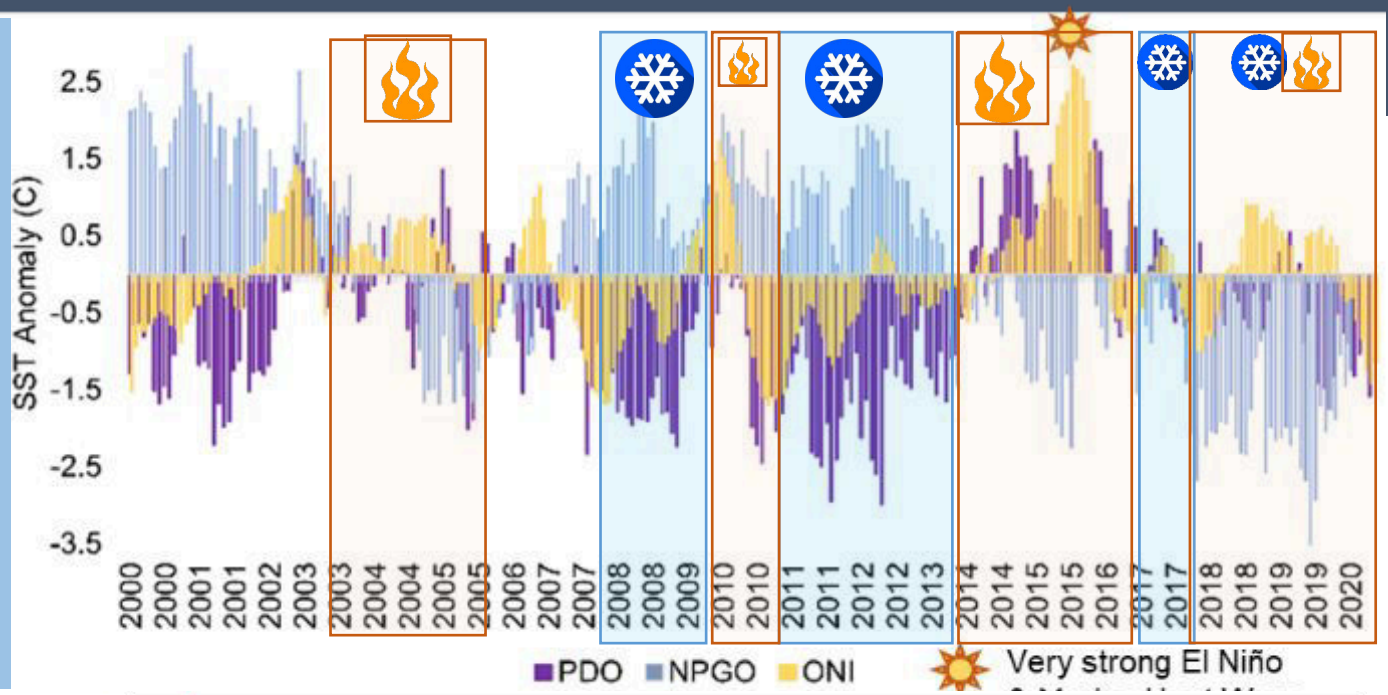


B. Gulf Islands

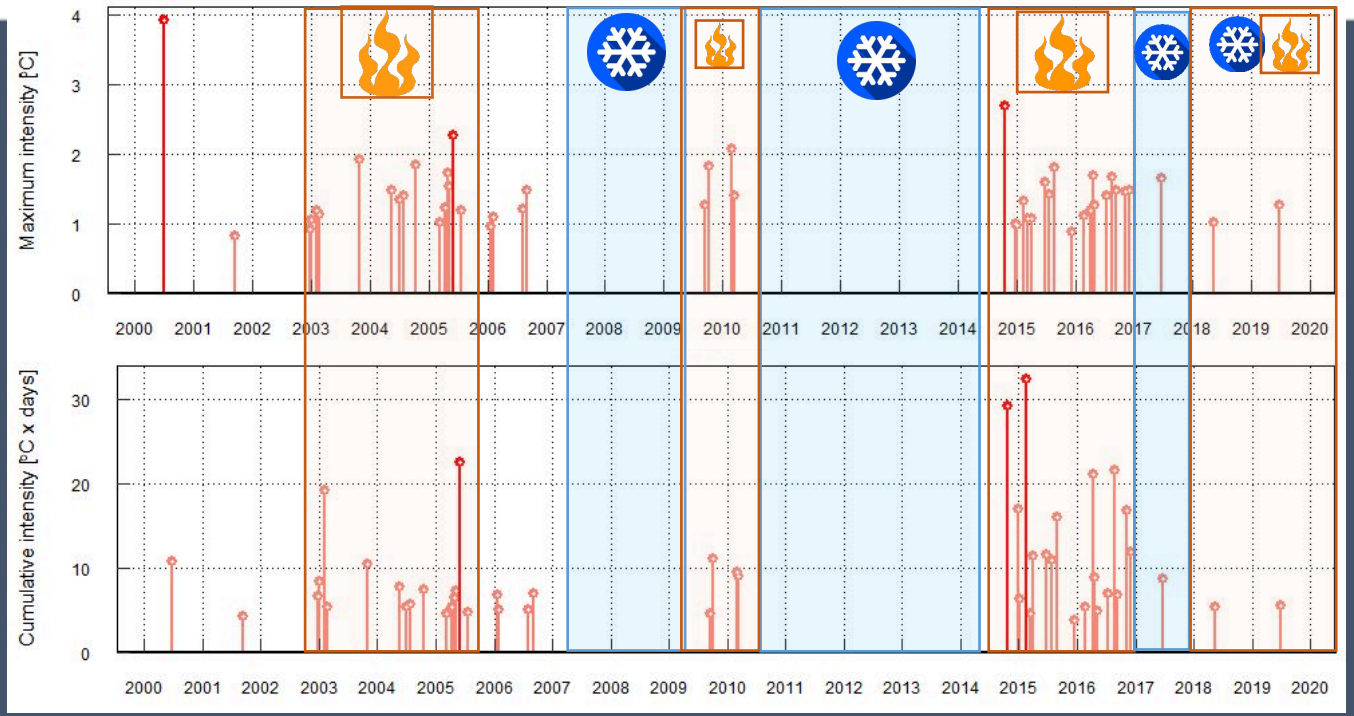




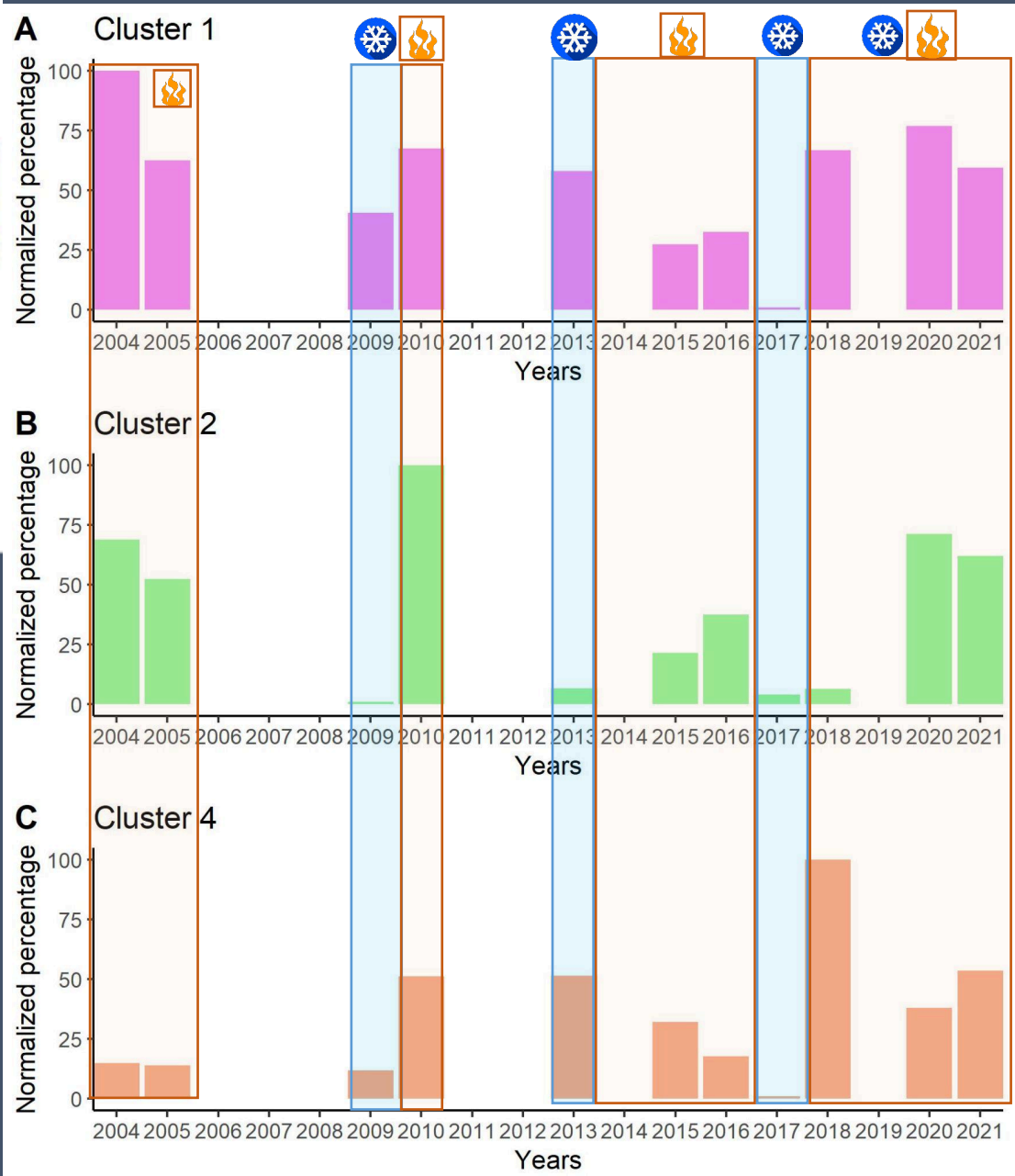
Oceanic Oscillations

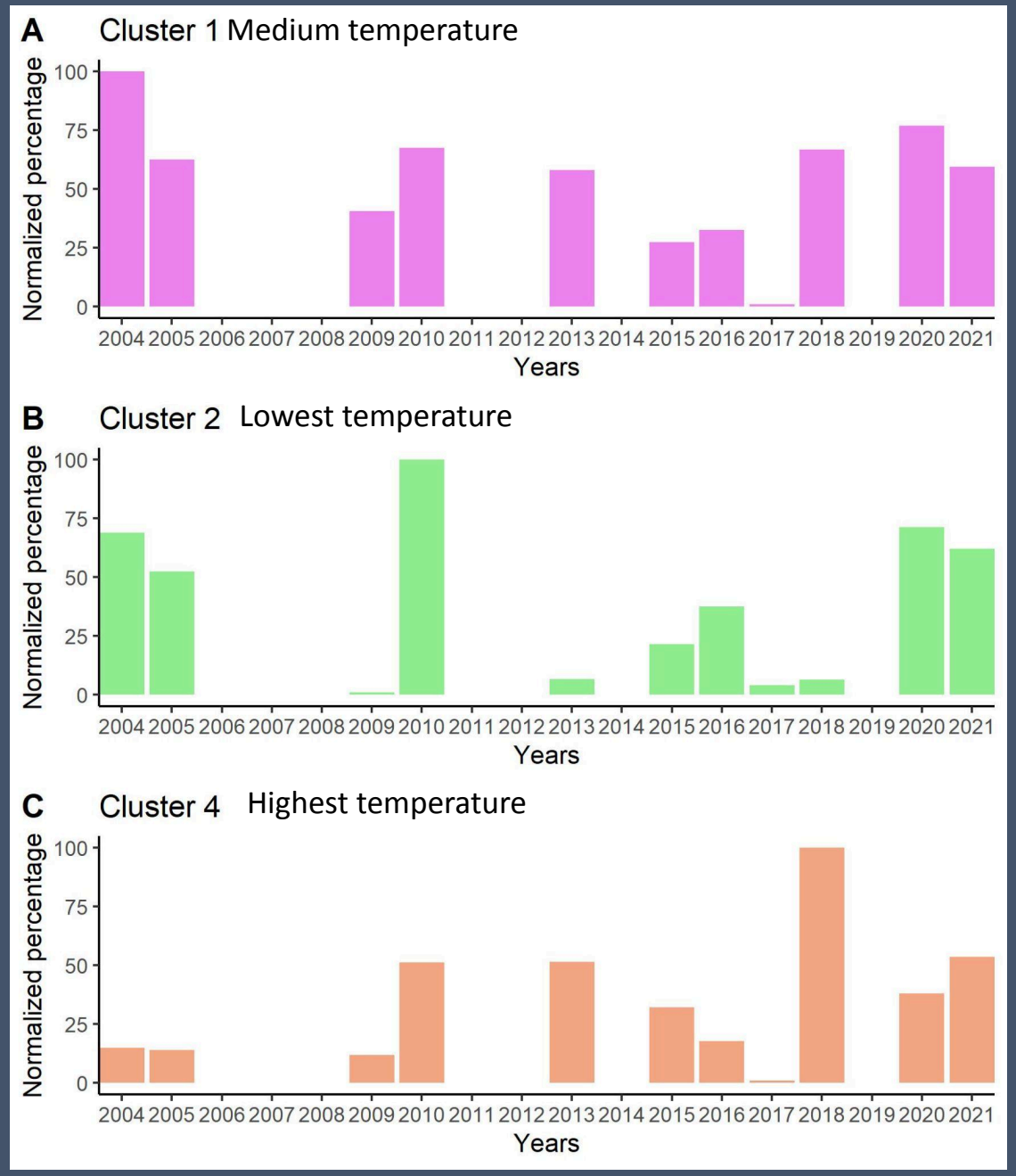


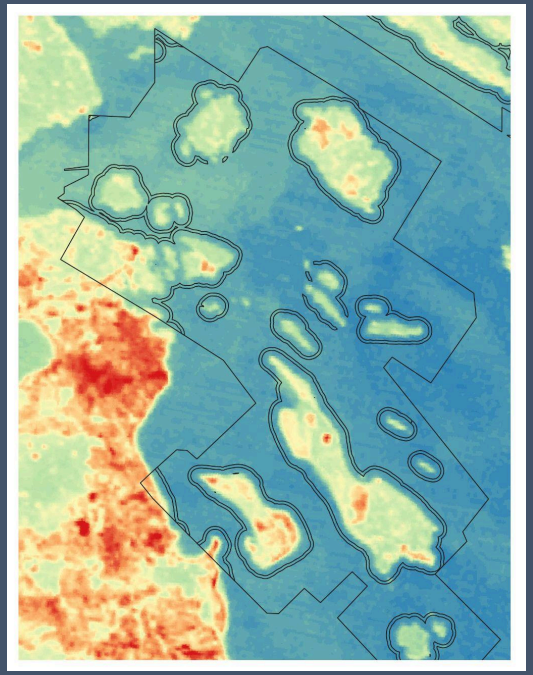
Marine heatwaves

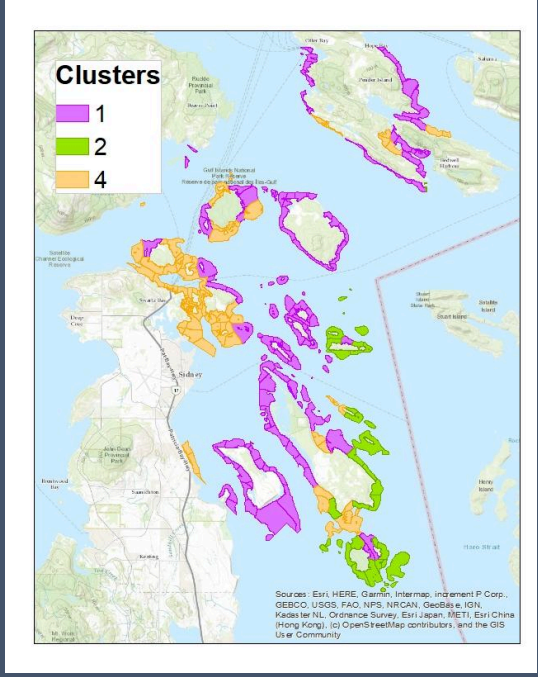


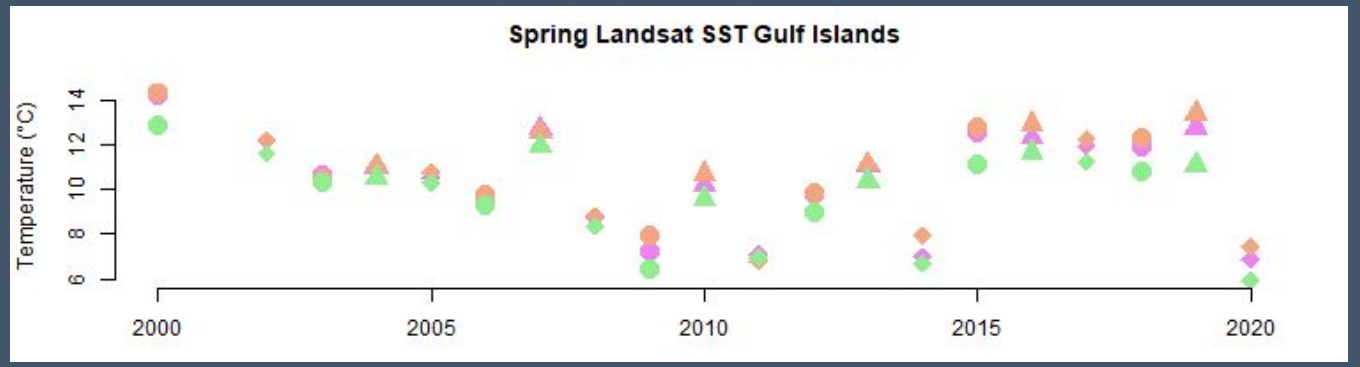
Kelp extent per cluster

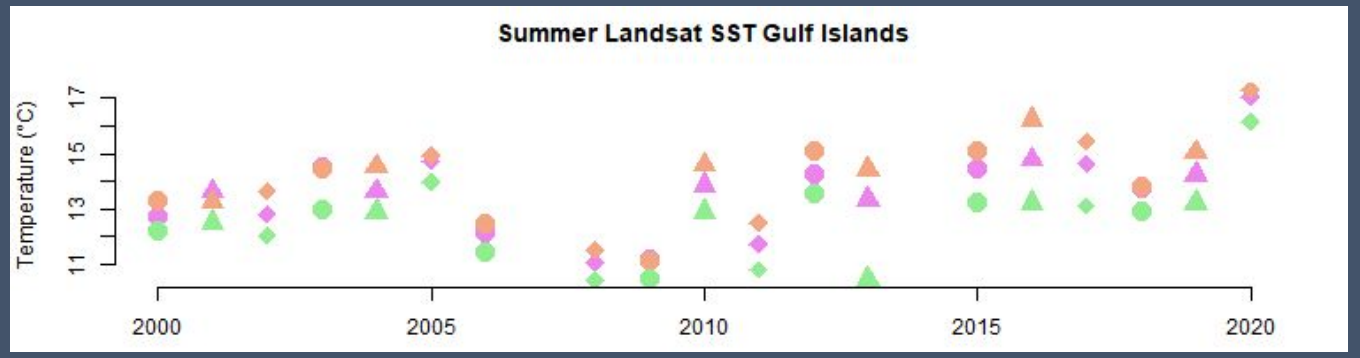



A
Cluster 1 Medium temperature
Normalized percentage
100
75
50
25
0
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Years
B
Cluster 2 Lowest temperature
Normalized percentage
100
75
50
25
0
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Years
C
Cluster 4 Highest temperature
Normalized percentage
100
75
50
25
0
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Years




Clusters
1
2
4


Spring Landsat SST Gulf Islands
Temperature (°C)
6
8
10
12
14
2000
2005
2010
2015
2020


Summer Landsat SST Gulf Islands
Temperature (°C)
11
13
15
17
2000
2005
2010
2015
2020

Final comments

- Similar conditions to other regions of the Pacific North American Coastline.
- Victoria to Sooke: Most resilient is the coldest cluster
- Gulf Islands: Most resilient are the warmer clusters
- KSSS: Kelp Sentinels of the Salish Sea