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ECOLOGICAL CHANGE, FIRE HISTORY, AND CLIMATE:

HOW LAND MANAGERS ARE USING PALEOECOLOGICAL RESEARCH IN THE ACTIVE MANAGEMENT OF ECOSYSTEMS

Marlow Pellatt



Parks
Canada

Parcs
Canada

Canada

The Team

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Canada's National Parks System Plan

Western Mountains

- 1. Pacific Coast Mountains
- 2. West of Coast Range Lowlands
- 3. Interior City Ranges
- 4. Columbia Mountains
- 5. Rocky Mountains
- 6. Northern Coast Mountains
- 7. Northern Interior Mountains
- 8. Pacific Plateau
- 9. Northern Coast Range
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Interior Plains

- 1. Manitoba Delta
- 2. Northern Plains
- 3. Southern Plains
- 4. Prairie Provinces
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Canadian Shield

- 1. Arctic Hills
- 2. Central Canada
- 3. Eastern Canada
- 4. Western Canada
- 5. Northern Canada
- 6. Southern Canada
- 7. Central Canada
- 8. Eastern Canada
- 9. Western Canada
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- 99. Western Canada
- 100. Northern Canada

Hudson Bay Lowlands

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- 36. Hudson

(Panel on Ecological Integrity Report, 2000)

Ecological Integrity

- The structure and function of the ecosystem is unimpaired by stresses induced by human activity.
- The ecosystem retains resilience because its biological diversity and supporting processes are likely to persist.



Temporal Scale

- What temporal baseline should be used to assess ecological integrity?
- Should ecological integrity be based on the ecological makeup of the area in question:
 - When the protected area was established?
 - Based on Aboriginal land use patterns?
 - Climate Change?
 - Other disturbance regimes, ecological trajectories, and environmental change?
 - Other characteristics we value?



Less than 5% of Garry oak ecosystems remain in a near-natural condition. More than 100 species of plants and animals are listed as “at risk of extinction”. Several species have already been extirpated.

The number of “at-risk” species and loss of habitat in the surrounding region make this park one of the most vulnerable in Canada.



Euphydryas editha taylori

Male, dorsal view
wingspan 4.0 cm



red, black
and white
markings

Female, dorsal view
wingspan 4.1 cm



Male, ventral view



black line
separating
orange and
reddish areas



Euphydryas editha taylori

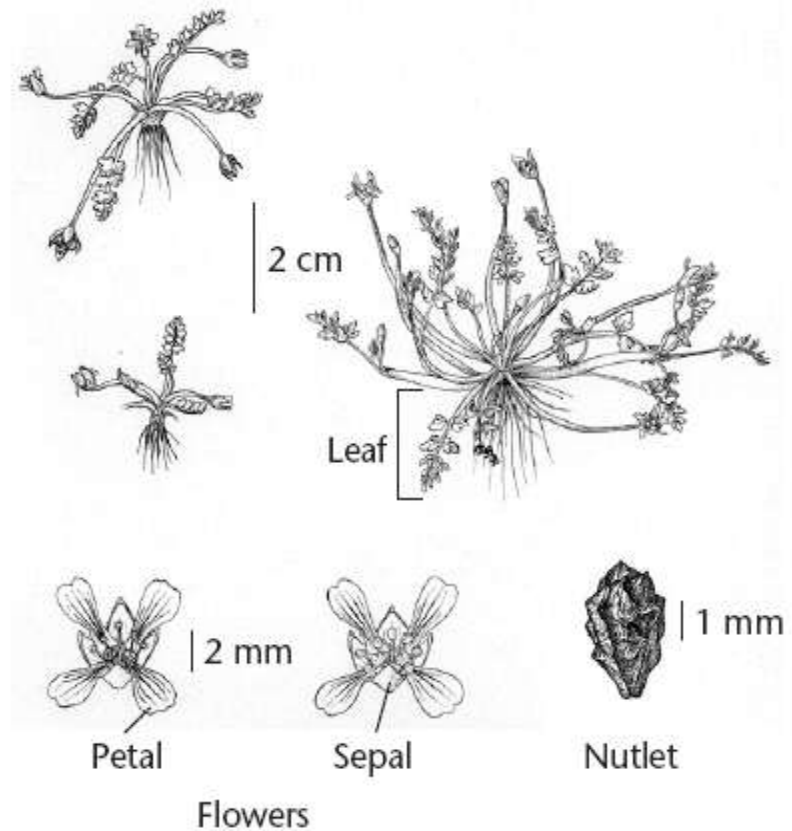
All photos: Crispin Guppy

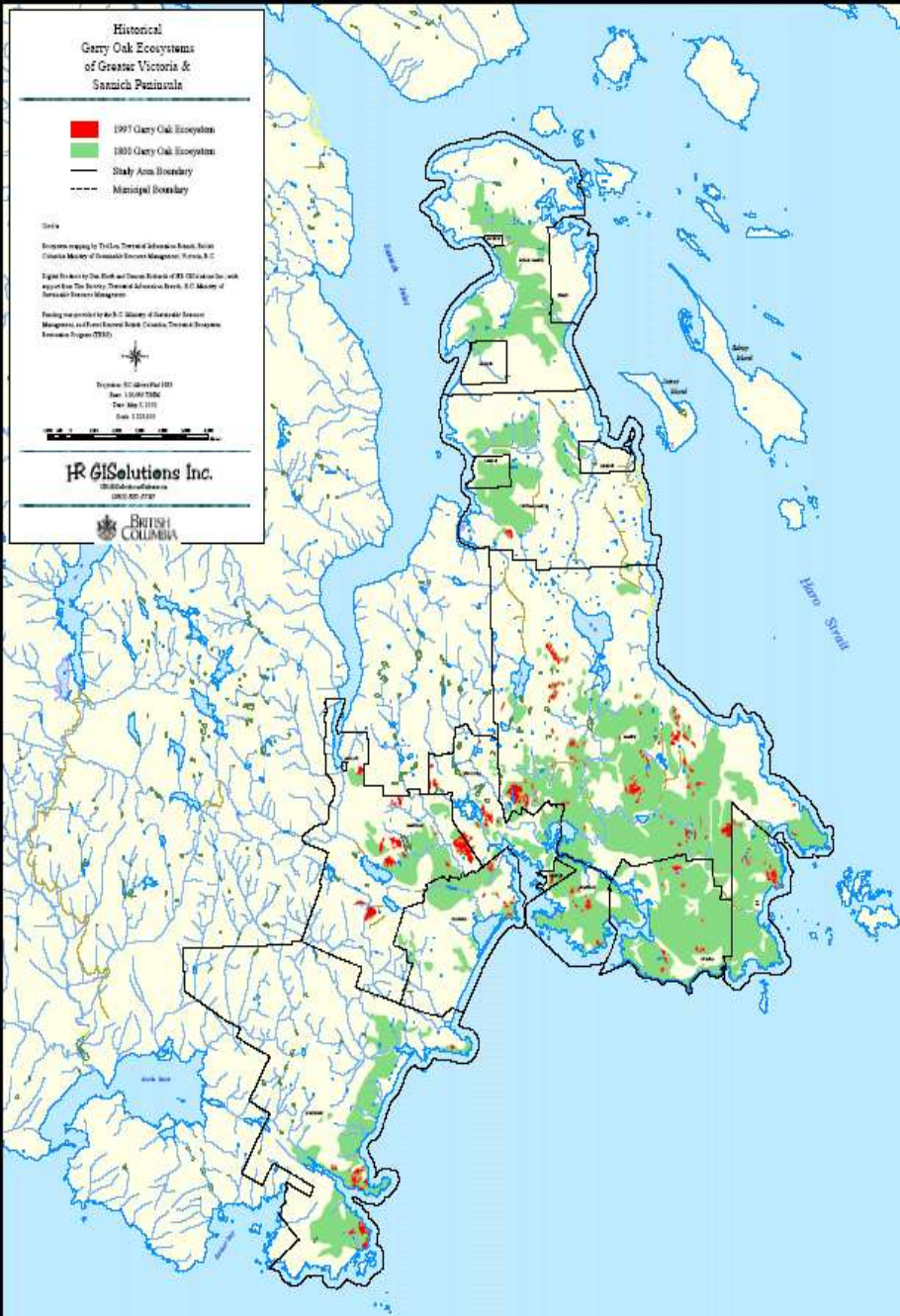
Macoun's meadow-foam



Adolf Ceska

Limnanthus macounii





Historical Garry Oak Ecosystems of Greater Victoria & Saanich Peninsula



1997 Garry Oak Ecosystems



1800 Garry Oak Ecosystems

Map: www.goert.ca

Very Brief History of Fire in BC's Garry Oak Ecosystems

Historical accounts indicate that Garry oak ecosystems were ignited in late summer and fall (Boyd 1986; Fuchs 2001; Turner 1999).

By the mid-1800s, however, as Europeans began clearing portions of southeastern Vancouver Island for agriculture, large fires were commonly observed (Grant 1857; Maslovat 2002).

The new "Government" restricted cultural burning in southwestern BC through the Bush Fire Act of 1874 (MacDonald 1929).



Terra Nullius

- Throughout the world, colonialism resulted in the suppression of aboriginal land management practices, abetted by the concept of ***terra nullius***, "belonging to no one"; the belief that aboriginal people had little influence on the land.
- Until recently, this ideology was entrenched in resource management and policy.
- Aboriginal People know this is not true. Their knowledge is supported by archaeological, palaeoecological and anthropological studies.



Objective

- We take a multidisciplinary approach (pollen, charcoal and tree ring analyses) to better understand the role of climate and fire in the formation of eco-cultural landscapes.



Paleoecology

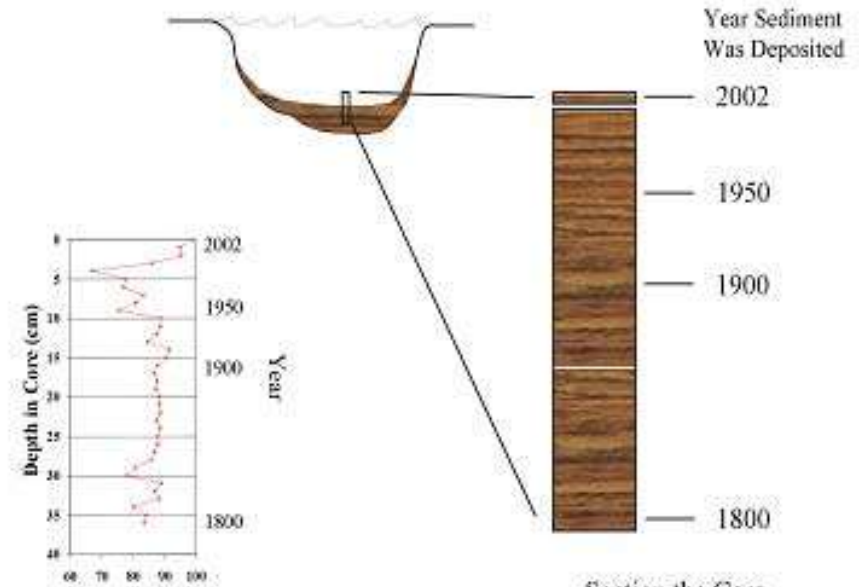
- Examine how ecosystems change through time to determine natural change and anthropogenic modification of the landscape
- The dynamic nature of ecosystems can be observed relative to time (seasonal to millennial scale) in order to understand ecological integrity



Lake Sediment Coring

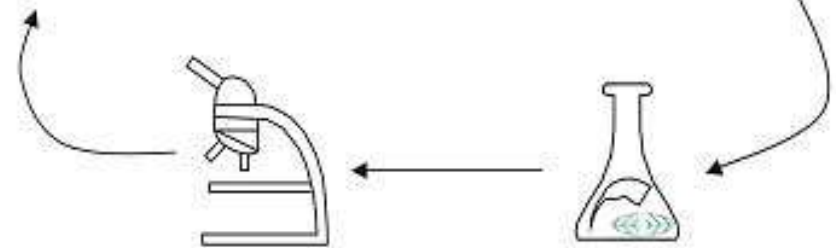


Retrieve a Sediment Core from Lake Bottom



Use Assemblages of Remains to Infer Past Conditions in the Lake

Section the Core Layer by Layer



Analyze and Identify Biological and Chemical Remains

Extract Biological and Chemical remains from Each Section of the Core



Pollen and Charcoal

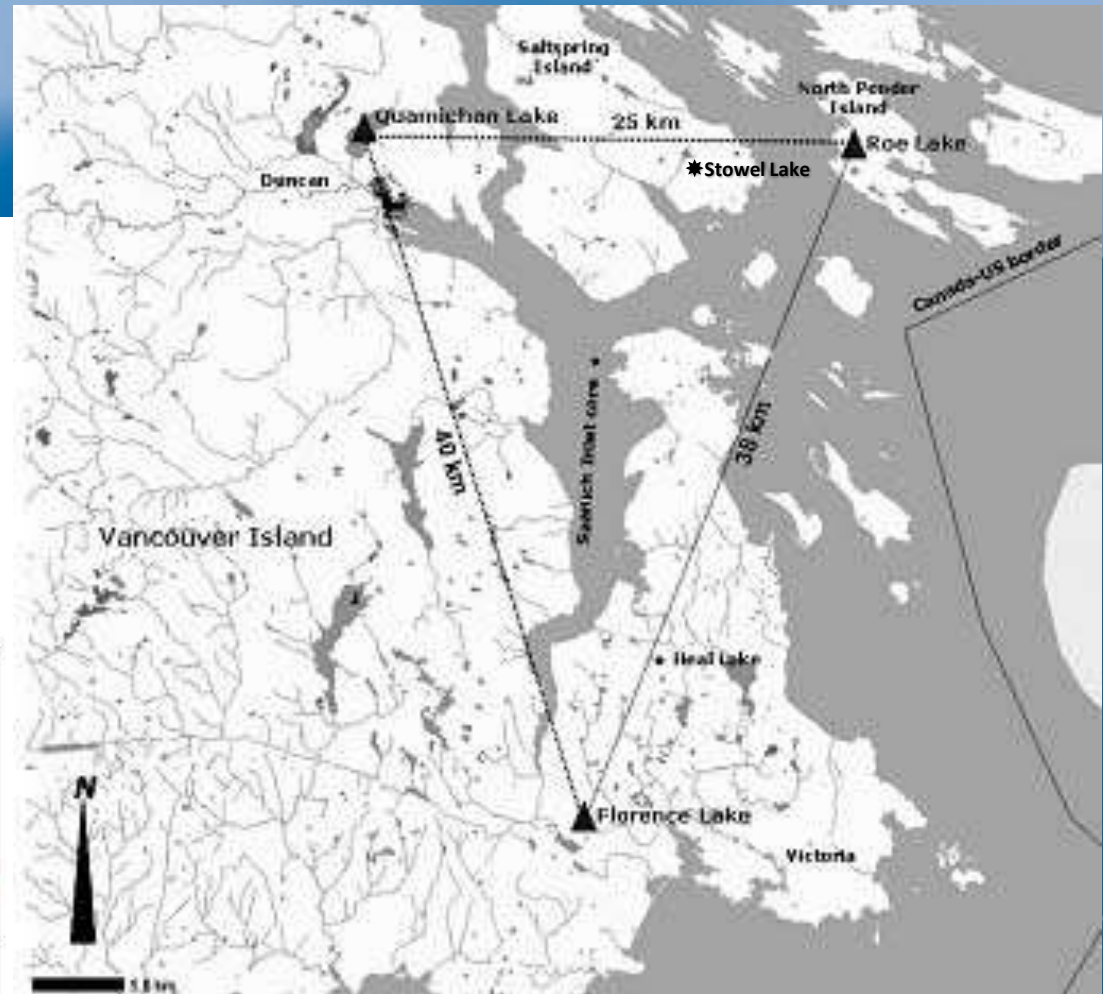
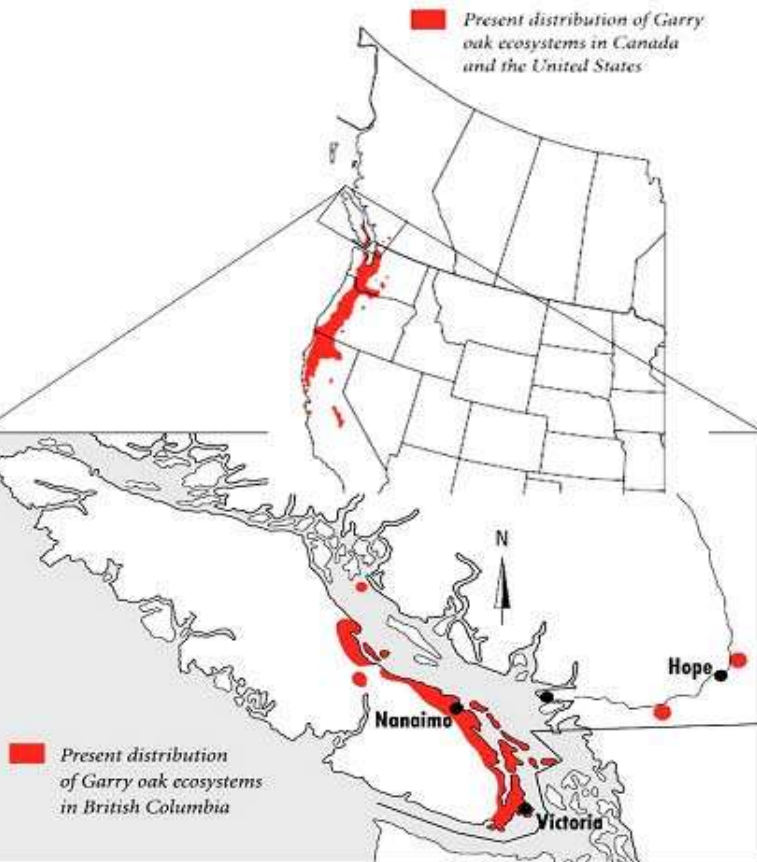


Abies pollen



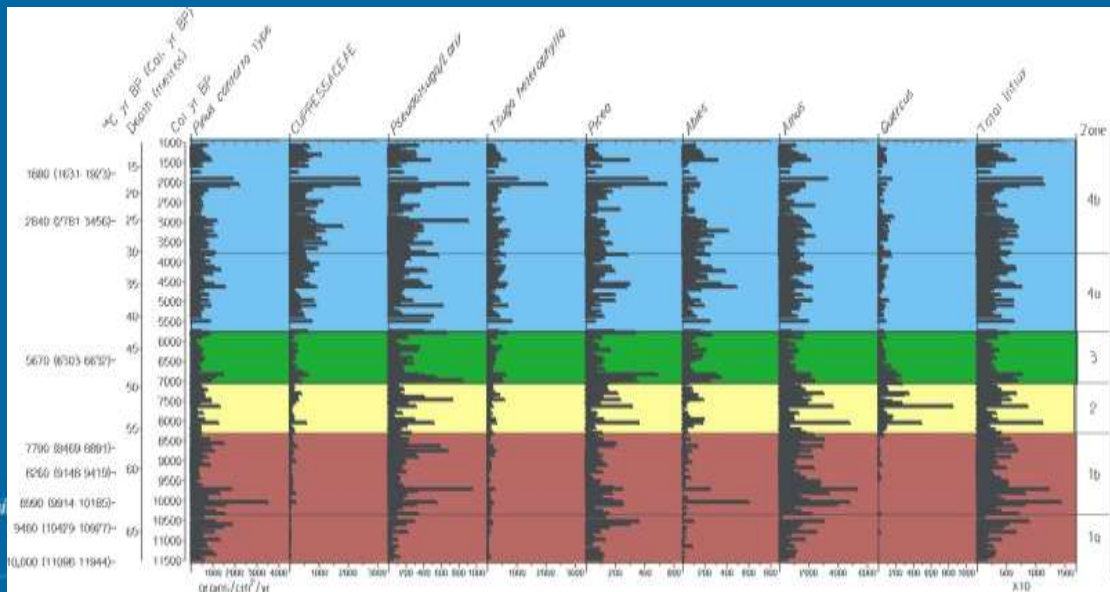
Charcoal

Study Sites for Palynological Research



Lessons from the Past

- Pollen analysis shows that in the early Holocene temperatures were 2 – 4C warmer than present. Oak greatly expanded about 8000 years ago, and although at lower values, oak and grass remain constant during a 5000 year period when shade-tolerant conifers such as cedar, western hemlock, and spruce are increasing.
- Since regional climate was becoming wetter, the persistence of oak pollen suggests that local influences maintained oak woodland and meadow environments near Saanich Inlet.
- Upon European contact, fire was observed in oak savannas in Oregon and southern Vancouver Island.





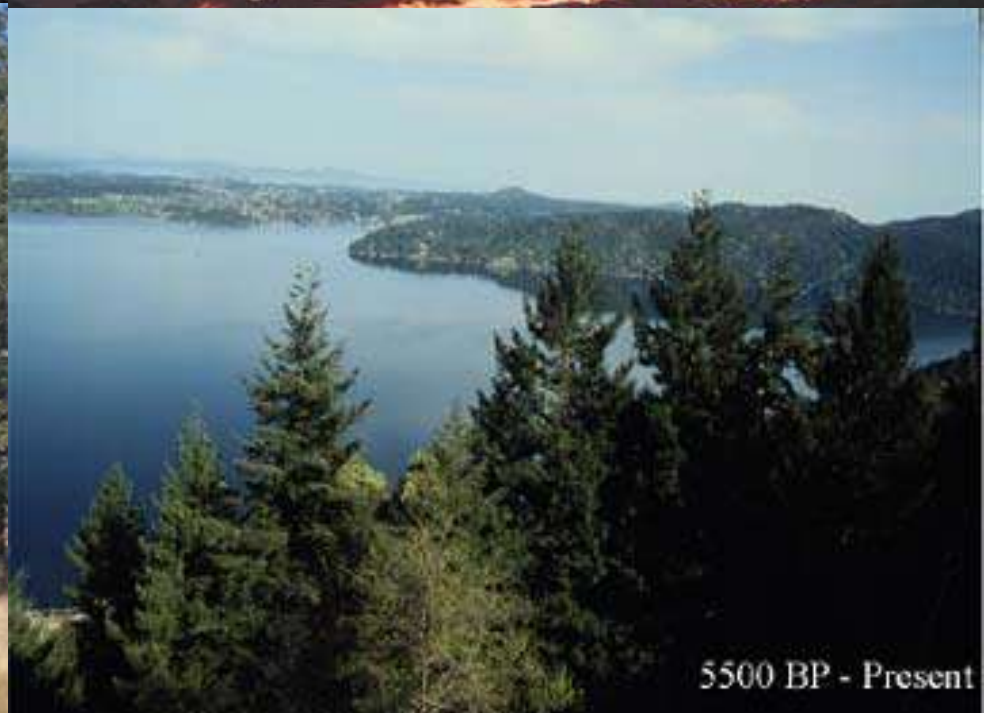
11500 – 8500 BP



11500 – 8500 BP



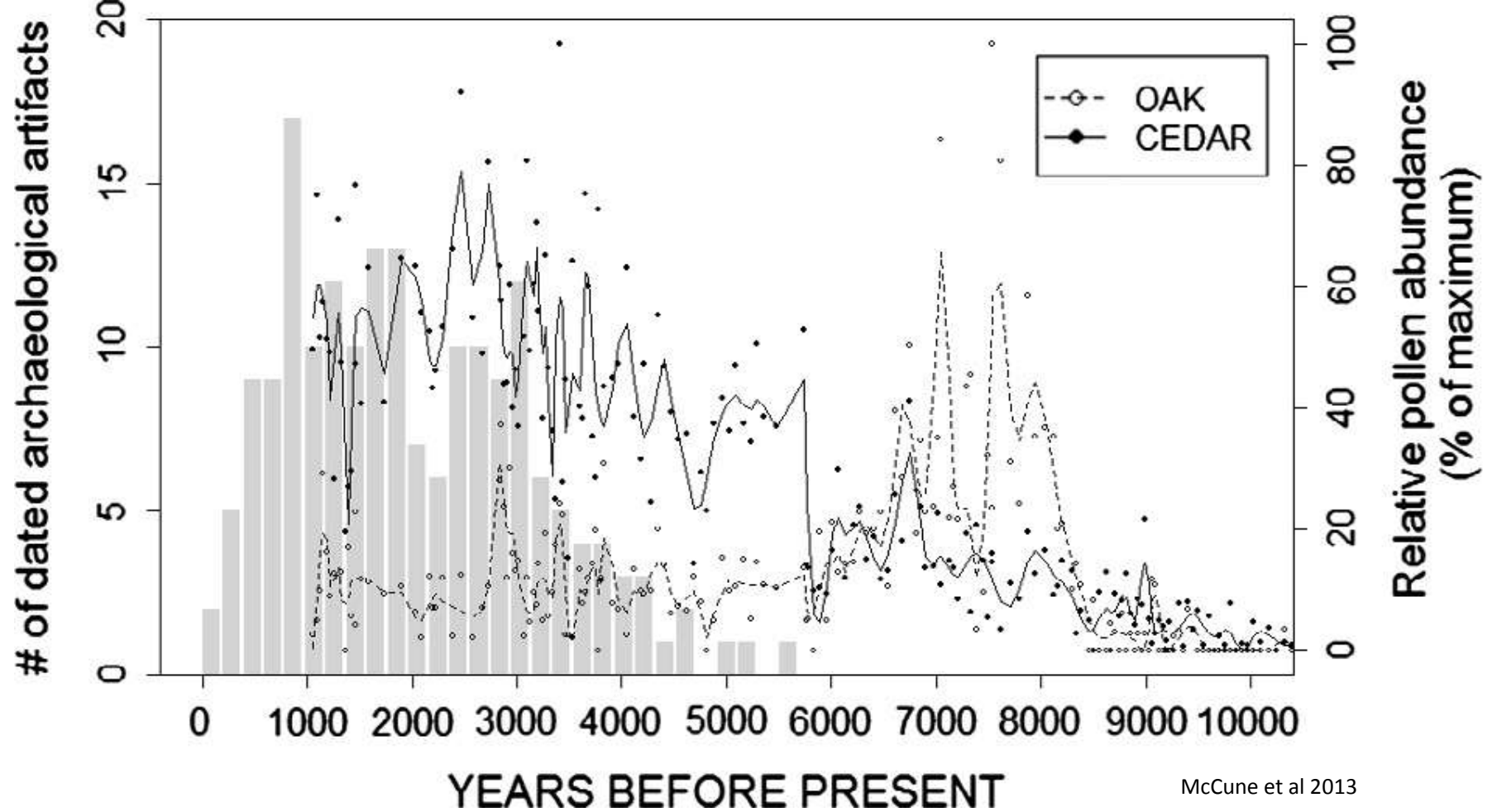
8500 – 7000 BP



5500 BP - Present

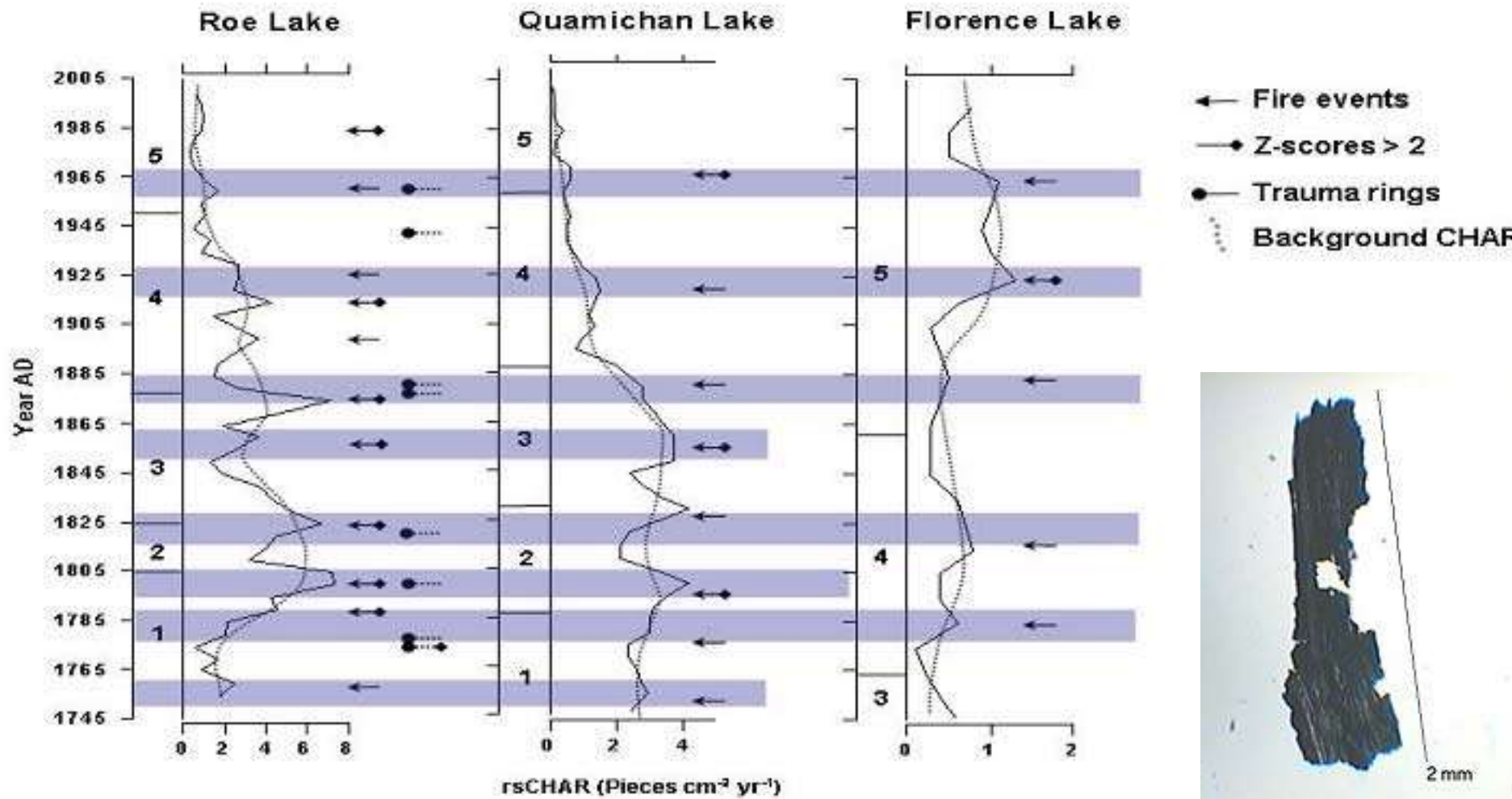
It is reasonable to hypothesize that aboriginal burning may have been important in maintaining Garry oak ecosystems over the last 3400 years.





Changing pollen abundance for Western red-cedar and Garry oak over the past 10,000 years, as a percentage of the maximum relative abundance for each species, from the Saanich Inlet sediment core (Pellatt et al., 2001). Dots are raw data; lines are locally weighted (LOESS) regression curves. Data for the most recent 1000 years was not available from this core. Bars show the age frequency of radiocarbon-dated materials from 71 archaeological sites within the range of Garry oak ecosystems on Vancouver Island (see Fig. 1 for site locations). We compiled archaeological data from the Canadian Archaeological Radiocarbon Database (Morlan, 2005). To avoid overrepresentation of sites with many radiocarbon determinations, we used only one radiocarbon date from each site per 200-year interval, resulting in a total of 185 individual dates.

Charcoal accumulation rate fire history for Study Sites (1745- 2003)



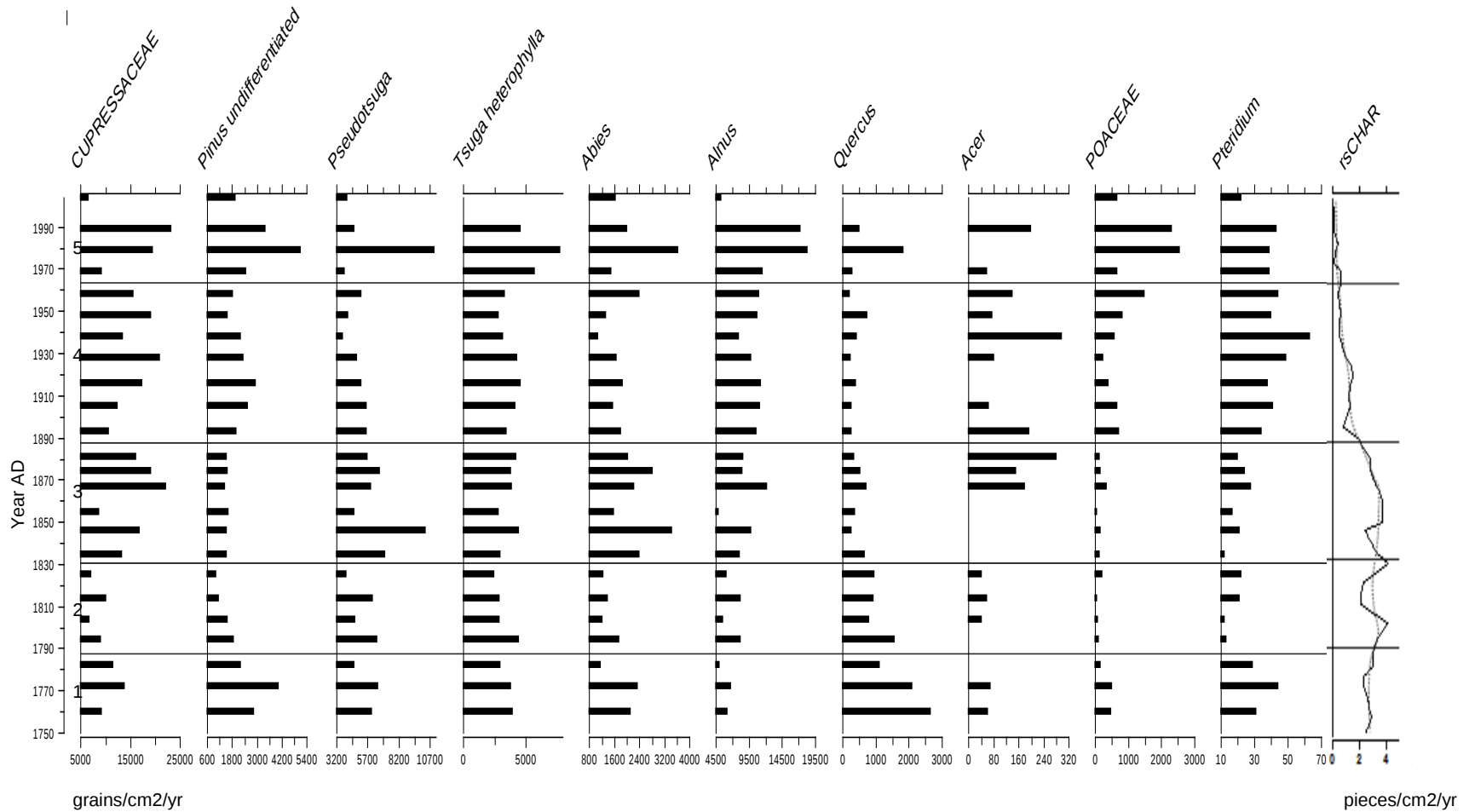
Grey bars span ca. 10 years and highlight fire events that appear coeval ± 10 years.

Mean Fire Return Intervals

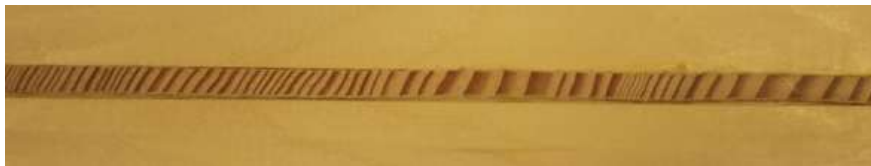
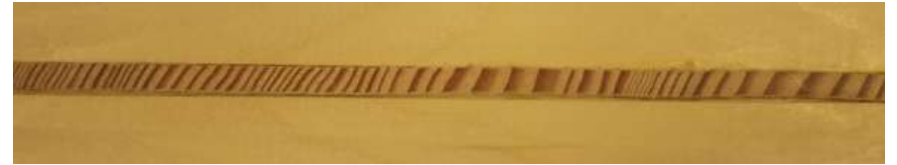
- Roe Lake ~ 27 years
- Quamichan Lake ~ 26 years
- Florence Lake ~ 41 years
- Fire events that occurred after ca. 1880 were excluded from the MFRI calculations.



Quamichan Lake Pollen Accumulation Rate Diagram



Tree Coring



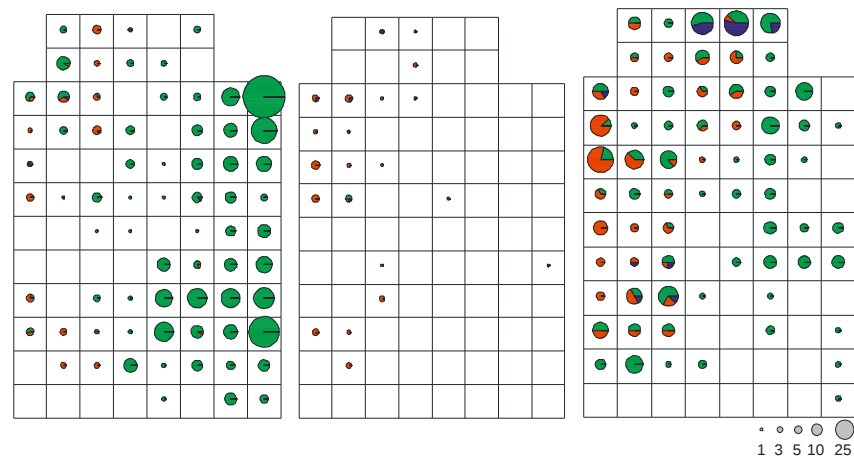
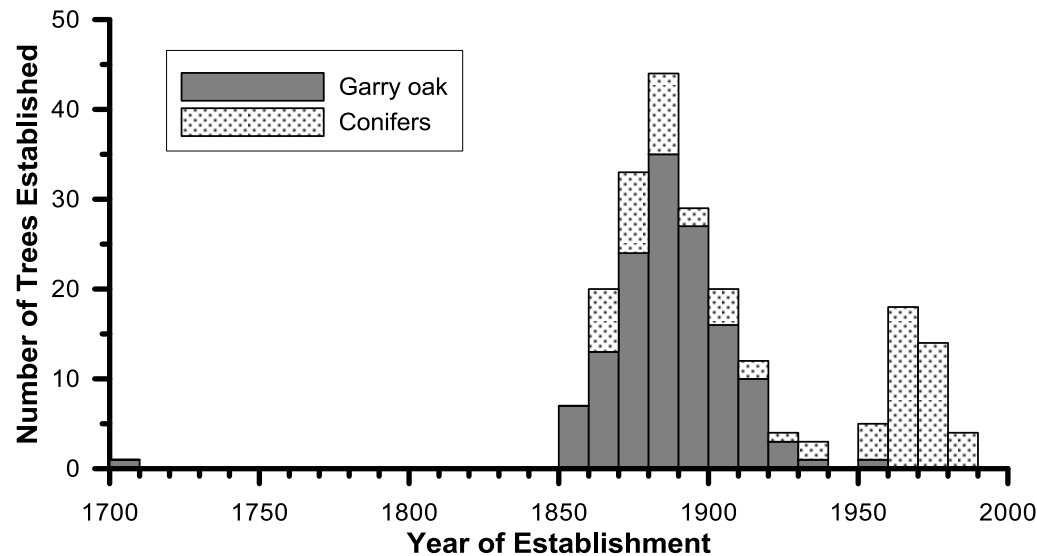
Tree Rings

Dendroecology at Rocky Point

Large stand, complex management history

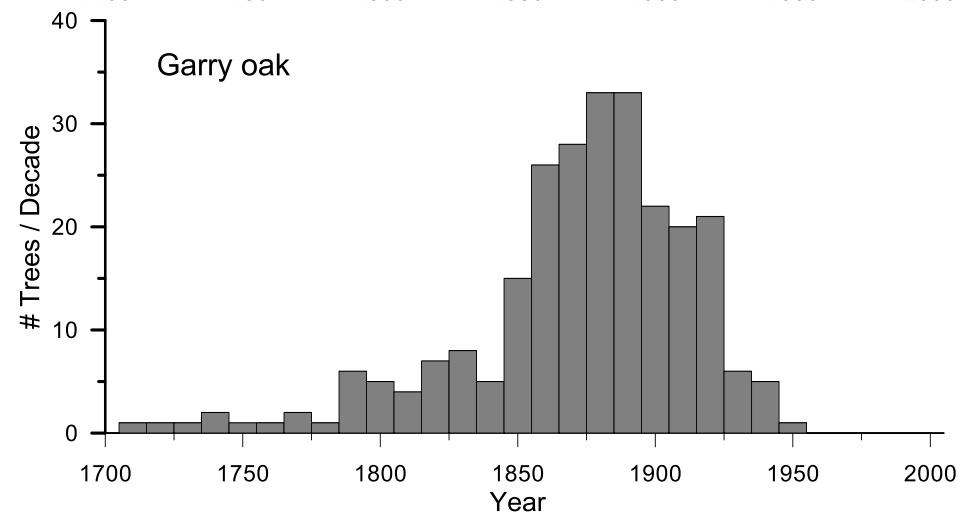
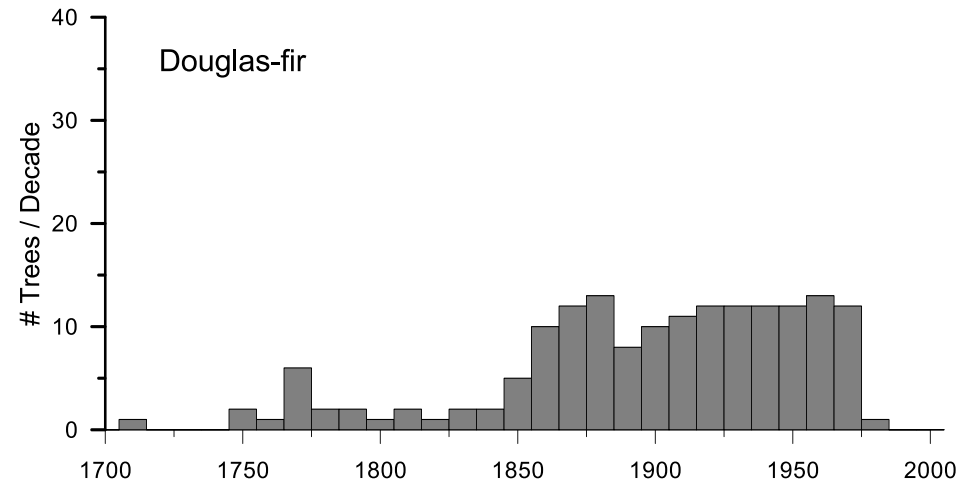
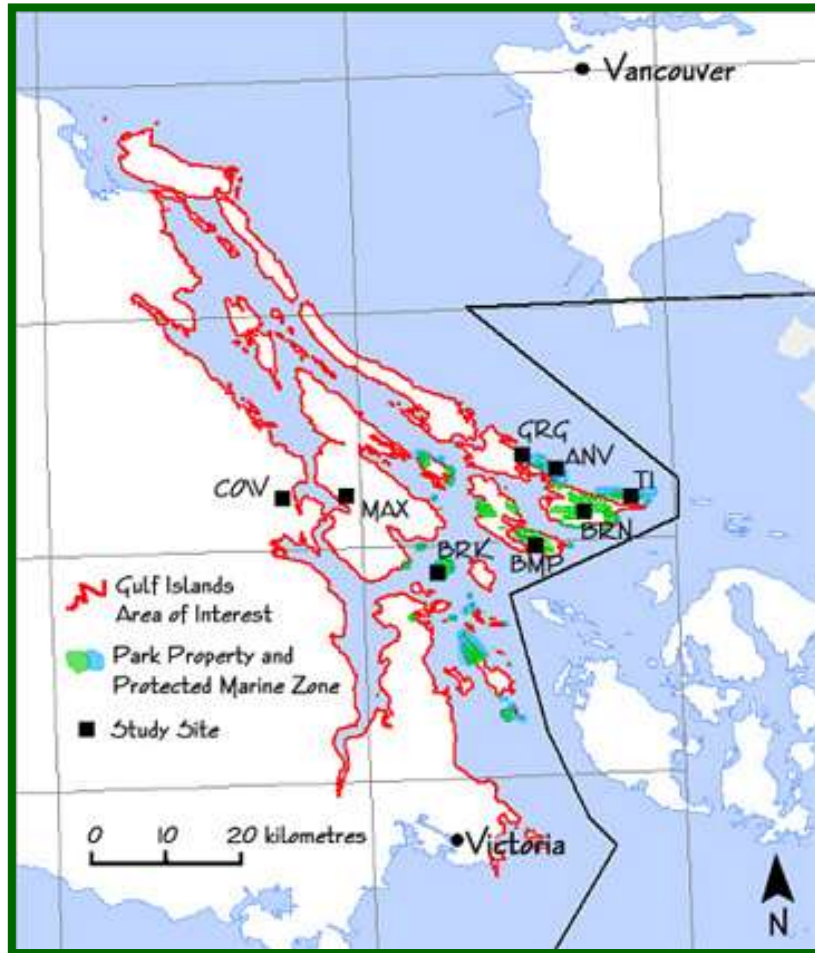


Rocky Point Stand Age



Number of trees per quadrat, and relative species proportions at site RPA for (A) seedlings, (B) saplings, and (C) trees sampled at site RPA. Garry oak is shown in green, Douglas-fir in red, and grand fir in blue.

Garry Oak Stands SW BC



Eco-Cultural Landscape

- Charcoal analysis indicate continuous and frequent prescribed burning events, with more severe fires occurring every 26–41 years in southwest British Columbia throughout the Anthropocene (last ~250 years) that substantially altered forest structure and composition.
- These results are consistent with stand age reconstructions in BC and Washington with Garry oak establishment beginning ~1850 AD, corresponding with modern fire exclusion, aboriginal population decline, and end of the Little Ice Age.
- Douglas-fir recruitment has been continuous since ~1900, with succession of oak woodland to closed conifer forest at most sites.



- These findings illustrate the change in ecosystem structure as a result of fire suppression and show that many Garry oak ecosystems have been profoundly influenced by eco-cultural practices.
- Overwhelming evidence indicates that in many cases these ecosystems are dependent on prescribed fire for their open structure.
- In the absence of aboriginal land-management practices, active management will be necessary to maintain Garry oak woodland.



The Future

The whole is more than the sum of the parts

- We are in a time of great change. We are recognizing that lands colonized in the past were not ***terra nullius***, but often had a rich history of land management activity that resulted in the ecosystems we value.
- The loss of eco-cultural land management activities often corresponds with the loss of valued ecosystems and species.
- In addition to social change, there is pressure brought about by climate change and the need to try to understand how species will adapt to change.
- Ecological restoration and intervention will become ever more intertwined as we attempt to manage for ecological integrity, species at risk, eco-cultural values, and climate change.



Paleoecology and Management

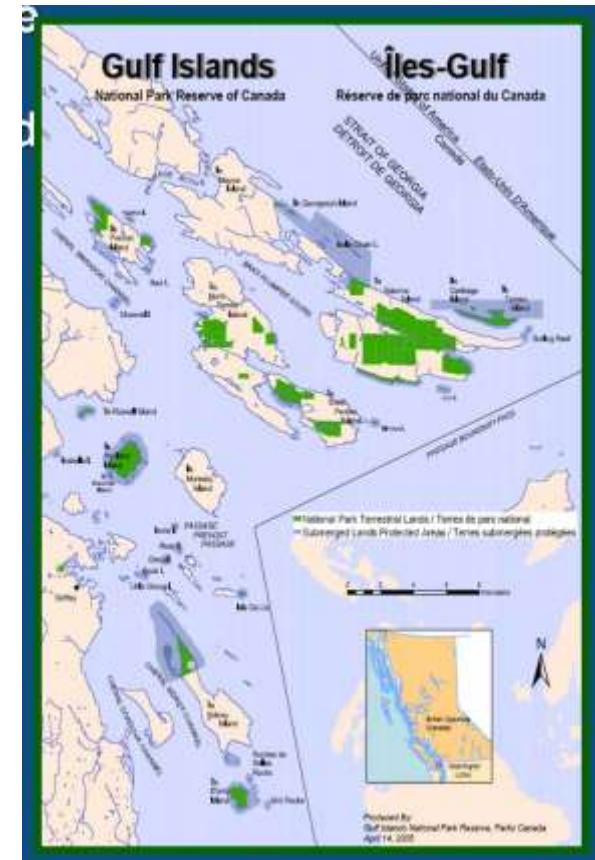
- Informs ecosystem intervention / restoration activities.
- Used by Parks Canada to inform prescribed burning in Mountain Parks, Terra Nova, Thousand Islands, Kejimikujik national parks.
- U.S.A. – Yellowstone National Park, Kanai National Wildlife Reserve
- Sweden - Jämtgaveln Nature Reserve
- And Gulf Island National Park Reserve.....



Tumbo Island Prescribed Burn

Our goal is to re-introduce fire following 150 years of fire suppression.

- The principle strategic goal is simple: to assess the consequences for plant communities of using prescribed fire as a restoration tool.
- In addition to fire we are excluding areas from deer browsing.



Tumbo Island PB Study Design

Proposed burn date Aug/Sept 2015

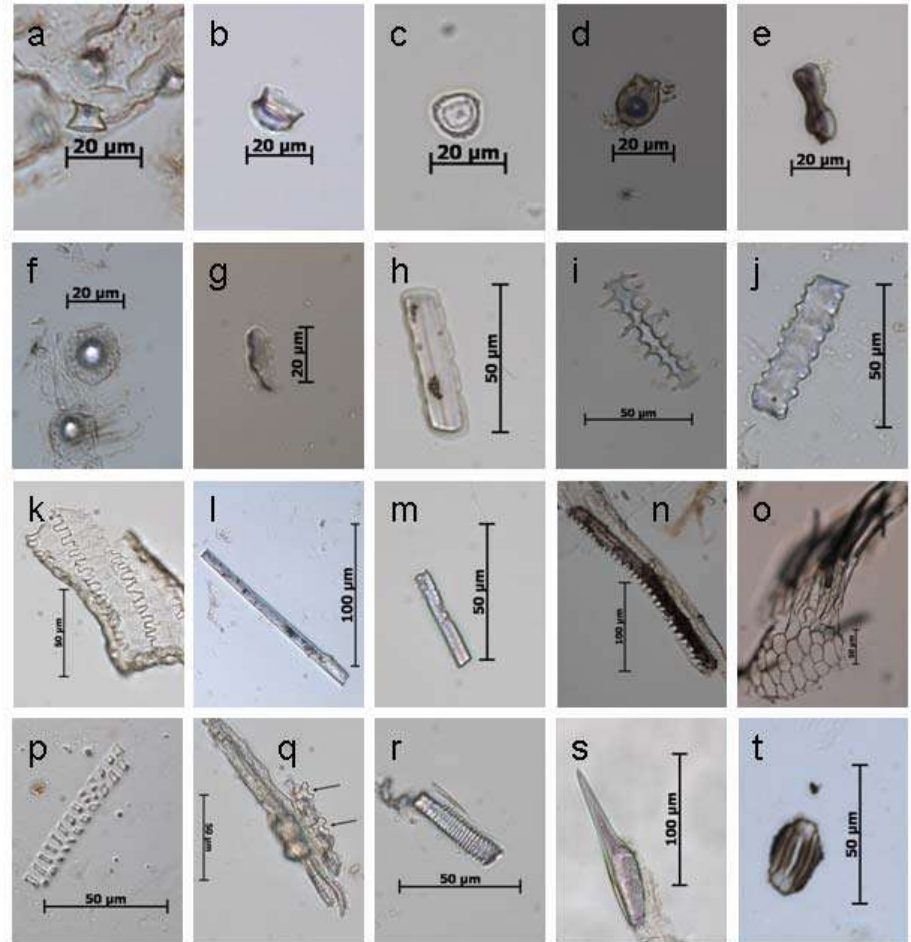
- **8 - 50mx50m units with 20 - 1m² sample plots per unit**
- **Pre-burn data collected 2010, 2012:**
 - Plant species composition
 - **native/non-native (31% non-native)**
 - Exclosures installed on ½ of sample plots
 - Fuel loading data collection 2012
 - Burn ½ of plots



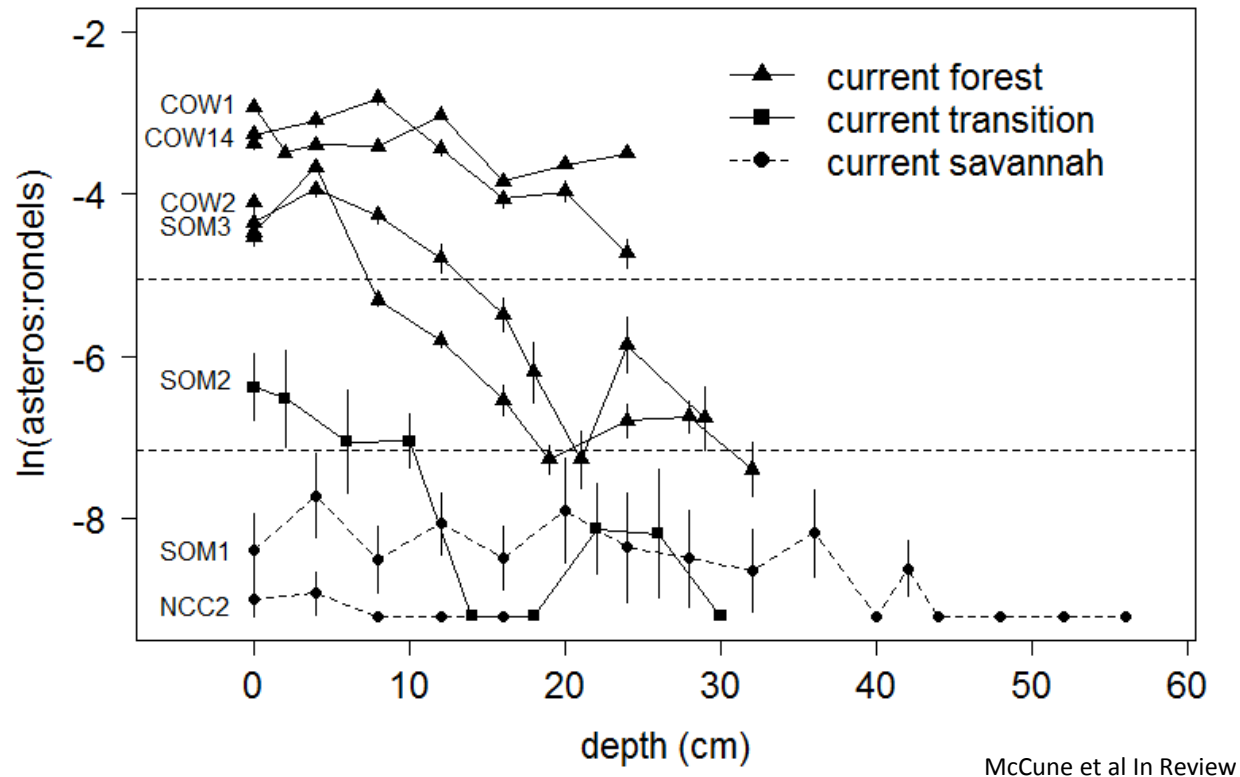
Phytoliths as an useful tool for selecting sites for ecological restoration.



**Douglas-fir Asterosclereid
phytolith**



**Phytolith morphotypes found in grass
species:**



Change with depth below the soil surface in the log of the ratio of asterosclereid to rondel phytoliths in the seven soil cores.

Dotted lines indicate the estimated thresholds between savannah vegetation (below lowest line), transition vegetation (between the two lines), and Douglas-fir forest (above the top line). Symbols indicate the present vegetation type of the plot from which each core was taken. Error bars are $\pm$ the bootstrapped standard error.

Challenges for Protected Area Managers

- There will be pressure to reconsider what the perceived function of a protected area is as the ecosystems within in it begin to change.
- The need to critically assess the purpose of a particular area and if it continues to be relevant to conservationists and the public.
- There is an absolute need to accept and integrate eco-cultural management practices to maintain desired ecosystem attributes and species.

