

Contrasting Vegetation and Fire Histories on the Point Reyes Peninsula During the Pre-Settlement and Settlement Periods

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Quaternary Sciences

Supported by:
National Park Service
(Point Reyes National Seashore)



Primary Collaborator:
Peter Brown (RMTRR)

Outline of Talk

- Introduction to Paleoecological Research
- Physical Setting of the Study Sites
- Vegetation & Fire Histories
 - Previous Research
 - Present Research
- Comparison with Other Sites along Coastal California
- General Considerations & Conclusions

How do paleoecologists collect data?

- Obtain Sediment Cores from Lakes, Bogs, Wetlands
- Isolate Pollen, Plant Macrofossils & Charcoal
- Compare Fossil Datasets to Modern Datasets

Sediment Coring – Lakes & Bogs

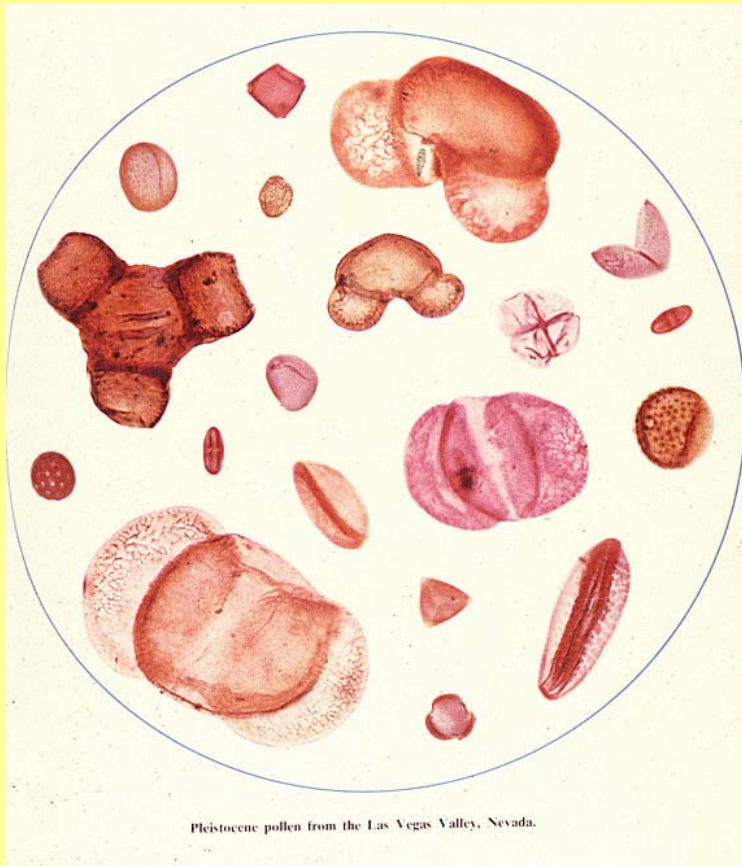


“Tools” of the Paleoeecologist

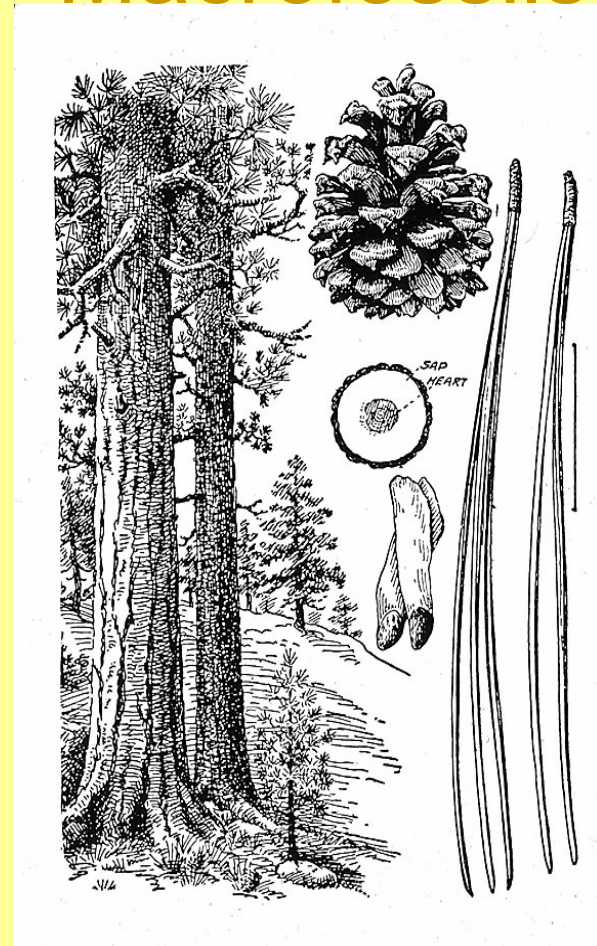


“Tools” of the Paleoeologist:

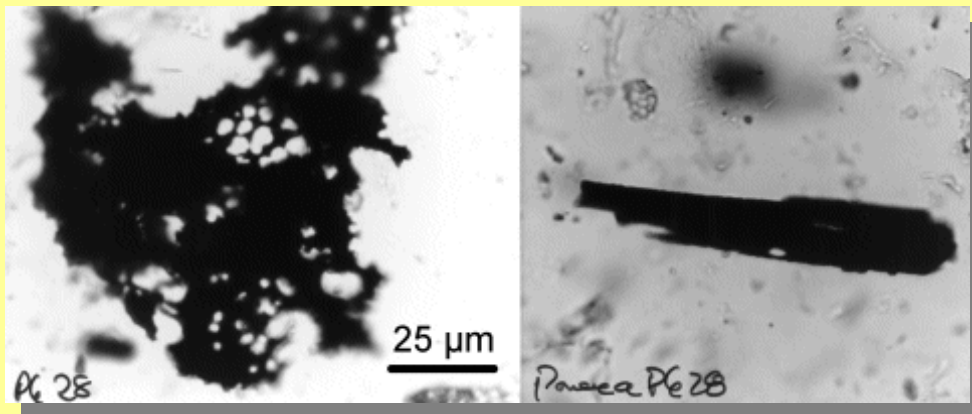
Pollen



Macrofossils



“Tools” of the Paleoecologist: Charcoal Particles



Microscopic Charcoal

<http://www.geo.arizona.edu/palynology/geos462/29charcoal.html>



Macroscopic Charcoal

<http://nrg.ncl.ac.uk/people/staff/tyson/gallery/gallery11.html>

Charcoal Production & Transport

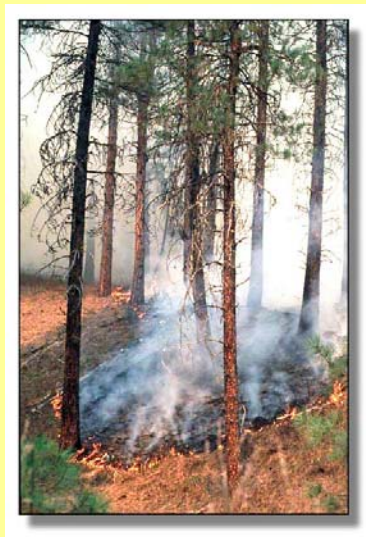
Production



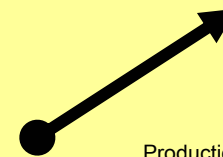
Transport



Deposition



+



Production & Transport, Clockwise from upper left:
http://www.atmos.umd.edu/~zli/Info/crown_fire-copy%20copy.jpg;
http://www.fs.fed.us/rm/hayman_fire/text/03rome/03_fig11.html;
<http://www.wapa.gov/media/cct/sept6/images/hayman4.jpg>;
http://www.kwphoto.com/Resources/Images/94_0007-20.jpg

Limitations of Paleoecology

- Not all species are preserved as fossils
- Not all body parts are preserved as fossils

Biocoenosis (life assemblage)

versus

Thanatocoenosis (death assemblage)

How do we age the sediments?

- Radiometric dating

- ^{14}C = range up to 40,000 years ago
- ^{210}Pb = range up to 150 years ago
- ^{137}Cs = 1964 AD peak in bomb testing

- Comparison with known historical events

- Comparison with known fires

History of Settlement & Use of Pollen for Dating

- 1817 - Spanish influence commenced here by establishment of San Rafael Franciscan mission (Brown et al.1999)
- After 1821 - Point Reyes opened to land claims, with the first granted in 1836 in the Olema Valley
- The area was subsequently opened for grazing and dairy ranching (Livingston 1994, 1995)
- The settlement period identified by increases in pollen indicators of grazing and land disturbance (i.e., dock [*Rumex*], plantain [*Plantago*], filaree [*Erodium*]), planted trees (*Eucalyptus*)

Paleoecological Research at PORE – 3 Previous Studies

- *Rypins et al. 1989 - Coast Trail Pond plus stratigraphic sections*
 - 12,300 ¹⁴C-yr record, begins w/ Douglas-fir – fir forest
 - 10,300 to 9,400 ¹⁴C yr ago transition to coastal sage scrub and grassland
- *Russell 1983 - Wildcat Lake*
 - 900 yr record (?)
 - Suggested alternation of importance of grassland and sage scrub vegetation
 - Charcoal concentration less above ca. 35 cm depth (age?)
- *Duncan 1992 - Mud Pond*
 - 1000 yr record
 - vegetation and ethnobotanical uses of plants by the Miwok at the time of European contact

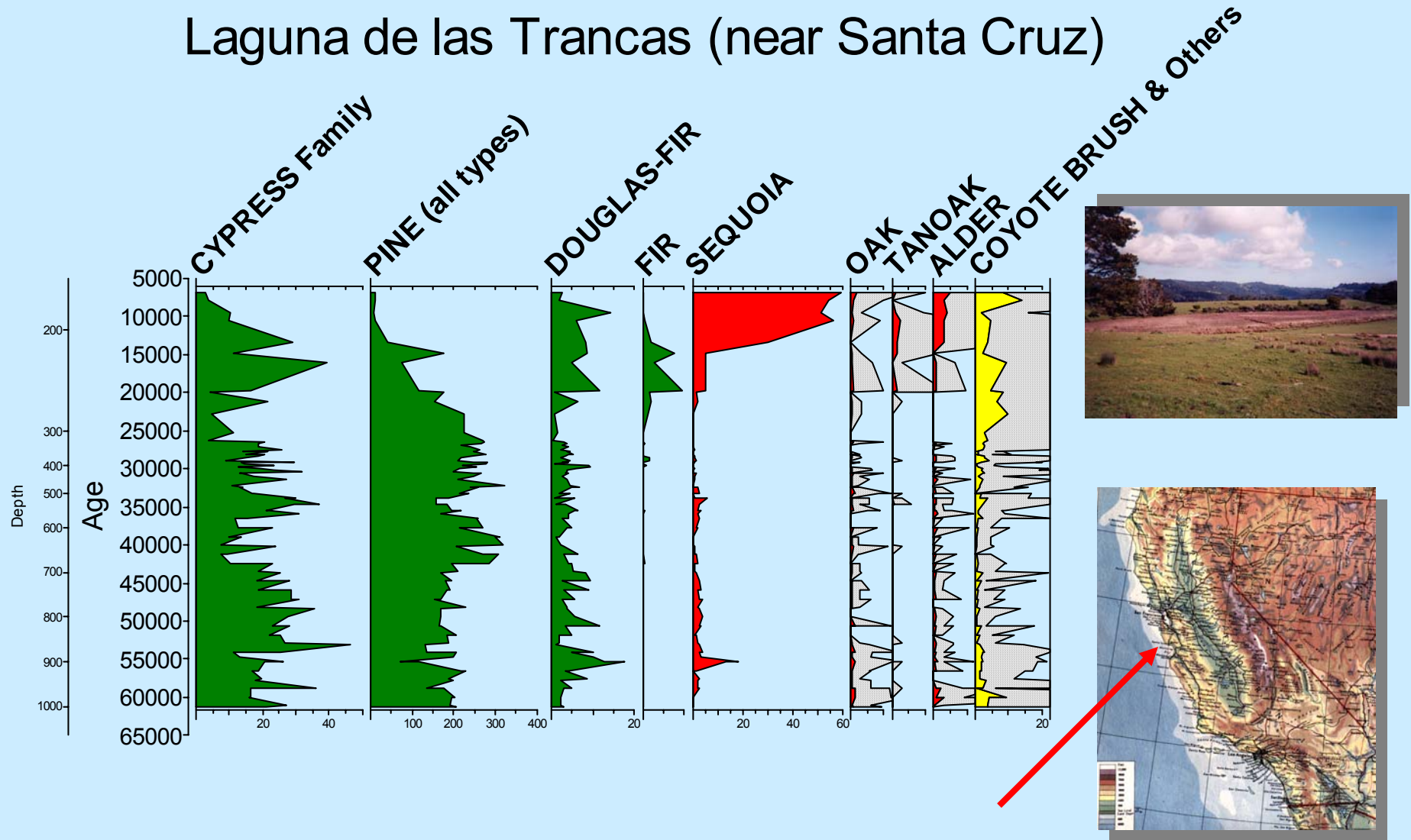
Terminology

(Ages Approximate)

- Late Pleistocene = prior to 11,500 years ago
- Holocene = since 11,500 years ago
 - Early Holocene = to 7000 years ago
 - Middle Holocene = 7000 to 4500 years ago
 - Late Holocene = 4500 years ago to 1850 AD
 - Settlement Period = after 1850 AD

The Last 65,000 Years Along the Coast

Laguna de las Trancas (near Santa Cruz)



Studies Sites on Point Reyes

- Coast Trail Pond
 - Glenmire
- Creamery Bay Bog
 - Wildcat Lake
- Shutter Ridge Pond

Why Choose These Sites?

- Examined a variety of wet areas
- Chose Sites from:
 - Range of vegetation types
 - Over an elevational gradient

Study Site Locations

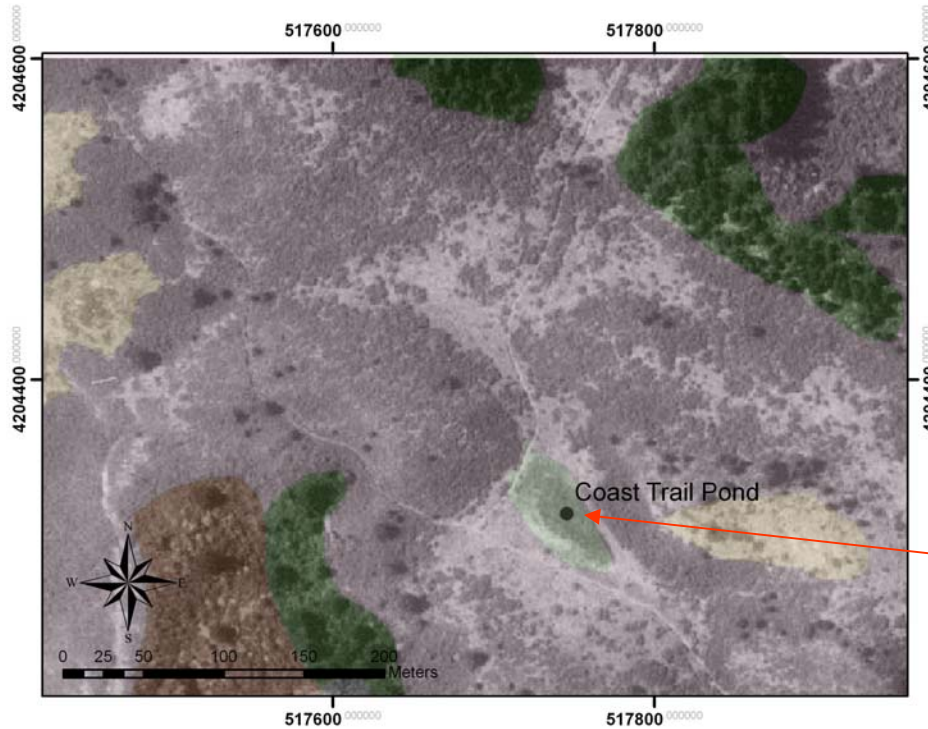


Coast Trail Pond



- 230 m above sea level
- Coastal scrub near closed forest
- Little historical data exists on the history of grazing at this site
- Oldest site in our study

Coast Trail Pond



Legend

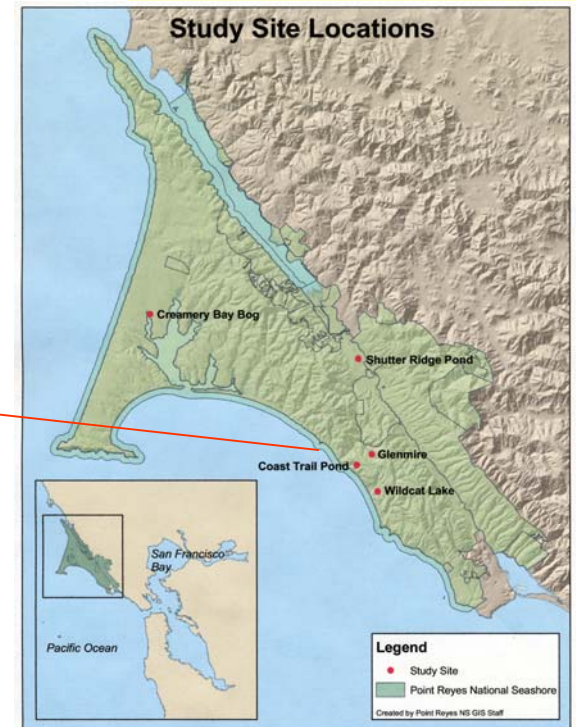
- Core Site

Coordinate System:
 Projection - Universal Transverse Mercator (UTM)
 Datum - North American Datum of 1983 (NAD 83)
 Zone - 10 North

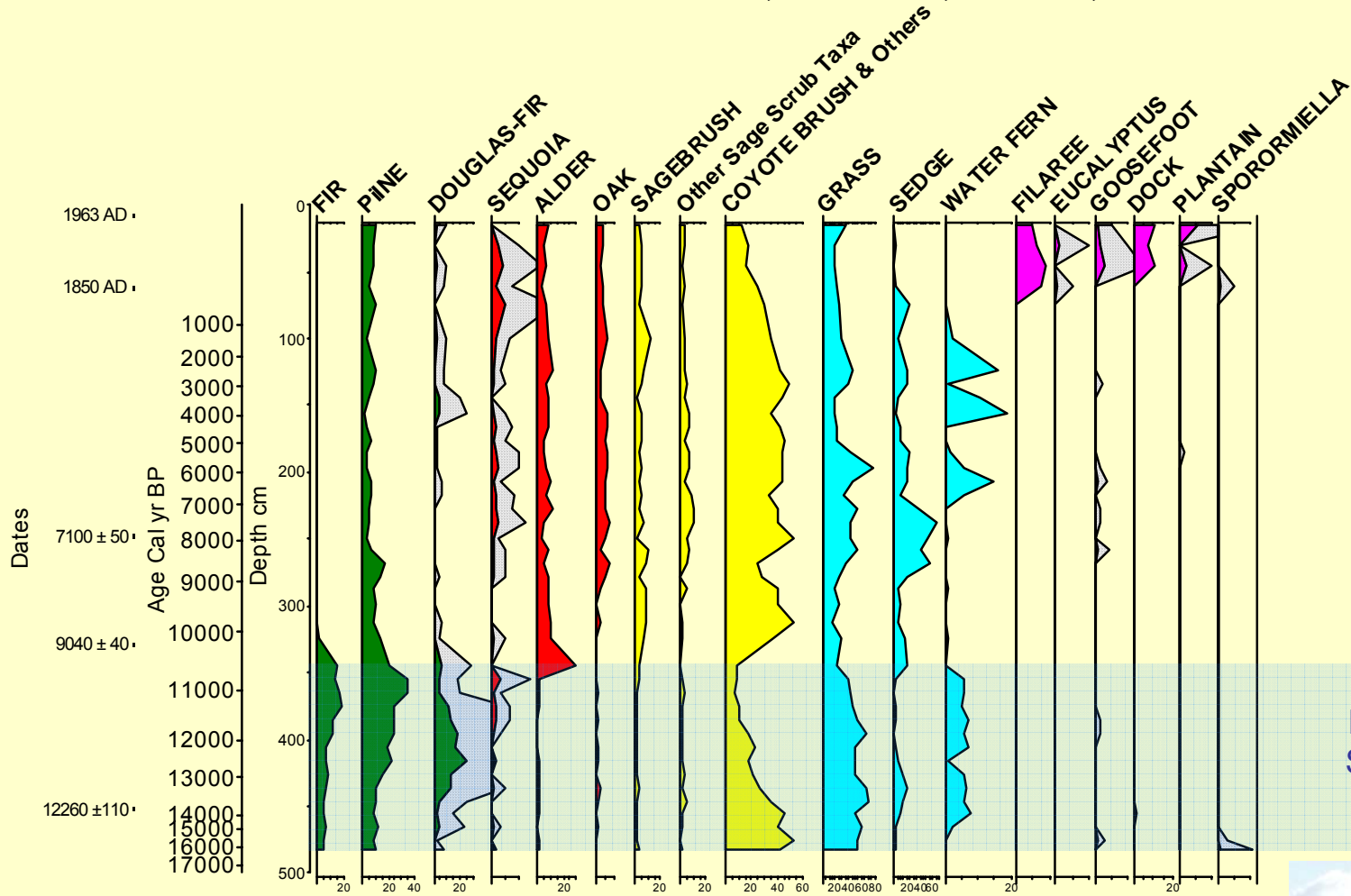
Point Reyes National Seashore Vegetation Map

ALLIANCE

- California Annual Grassland with Native Component Mapping Unit
- Coffeeberry
- Coyote Brush
- Douglas-fir
- Introduced Coastal Perennial Grassland Alliance



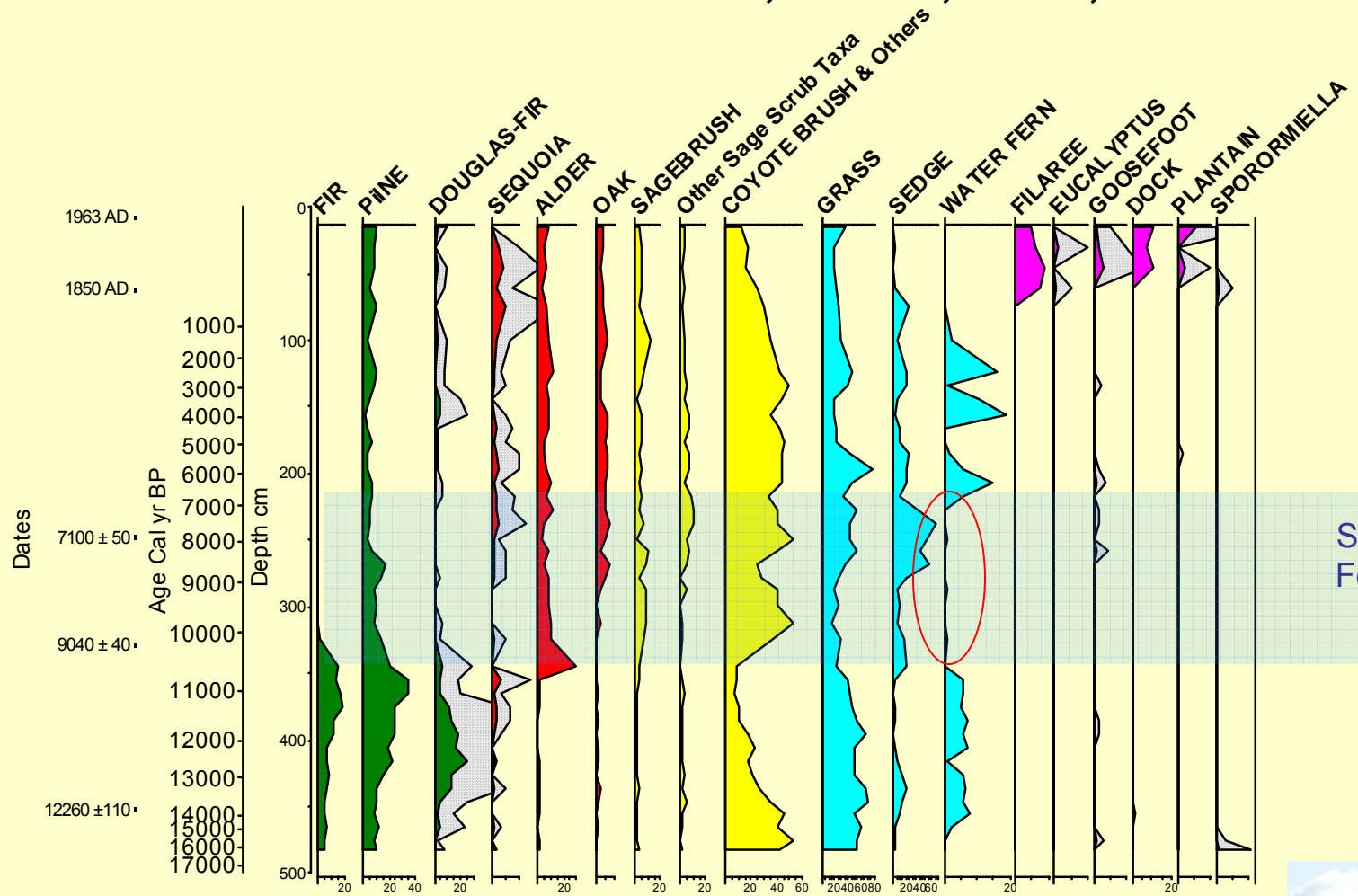
Coast Trail Pond - Trees, Shrubs, Herbs, Wetland



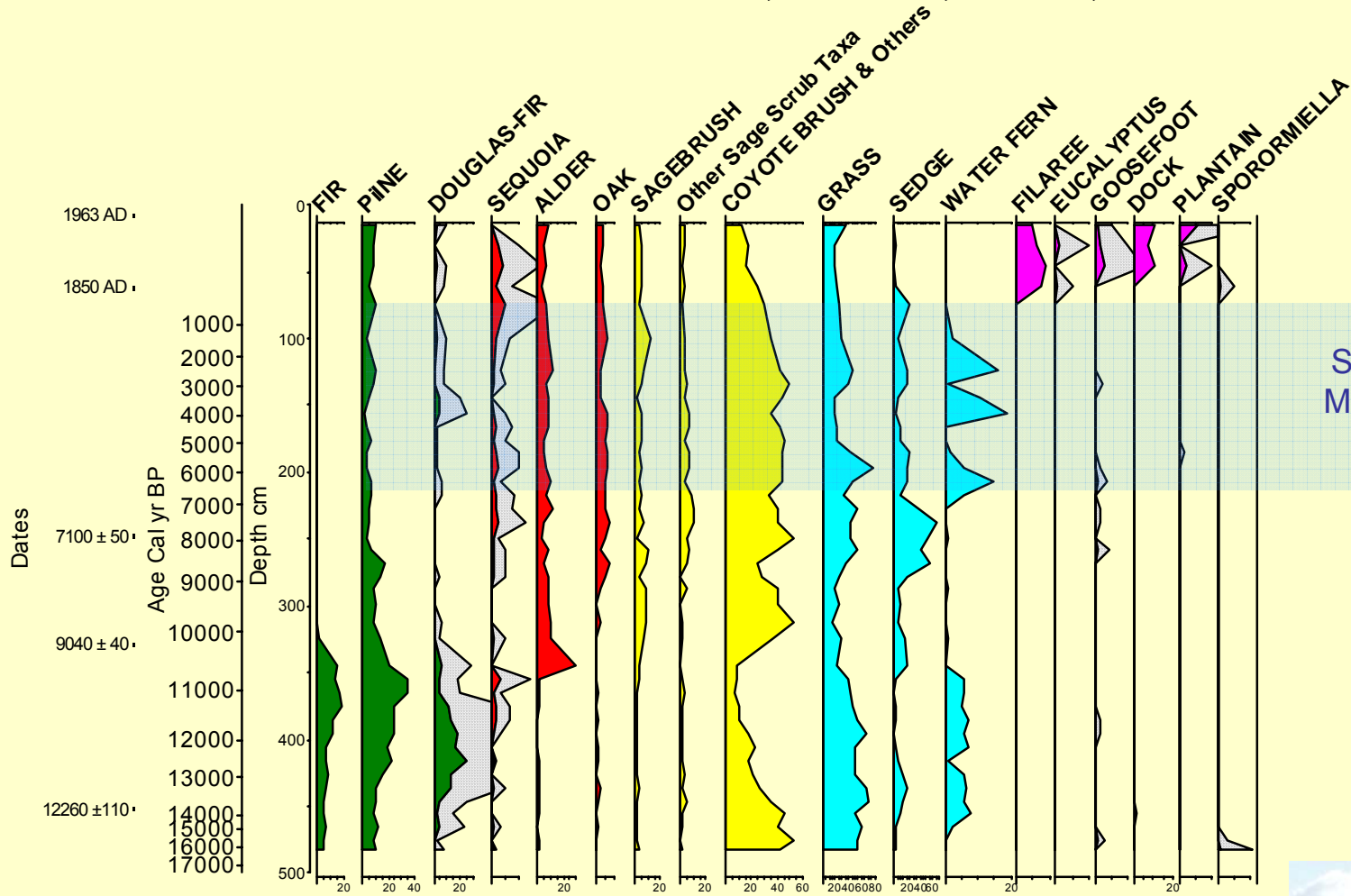
Forest and Sage Scrub



Coast Trail Pond - Trees, Shrubs, Herbs, Wetland



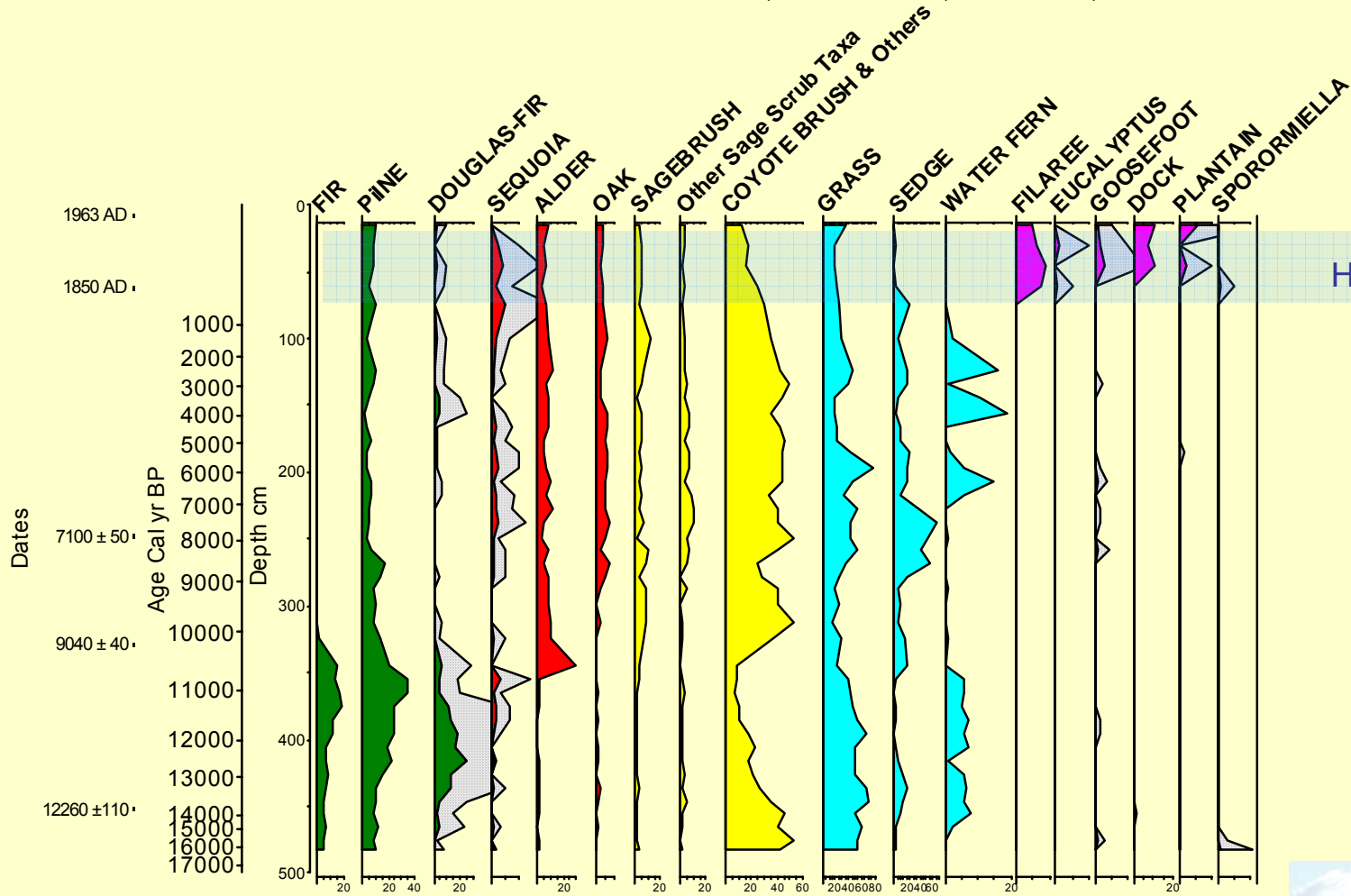
Coast Trail Pond - Trees, Shrubs, Herbs, Wetland



Sage Scrub w/
Mixed Hdwds &
Conifers



Coast Trail Pond - Trees, Shrubs, Herbs, Wetland



Historic Period

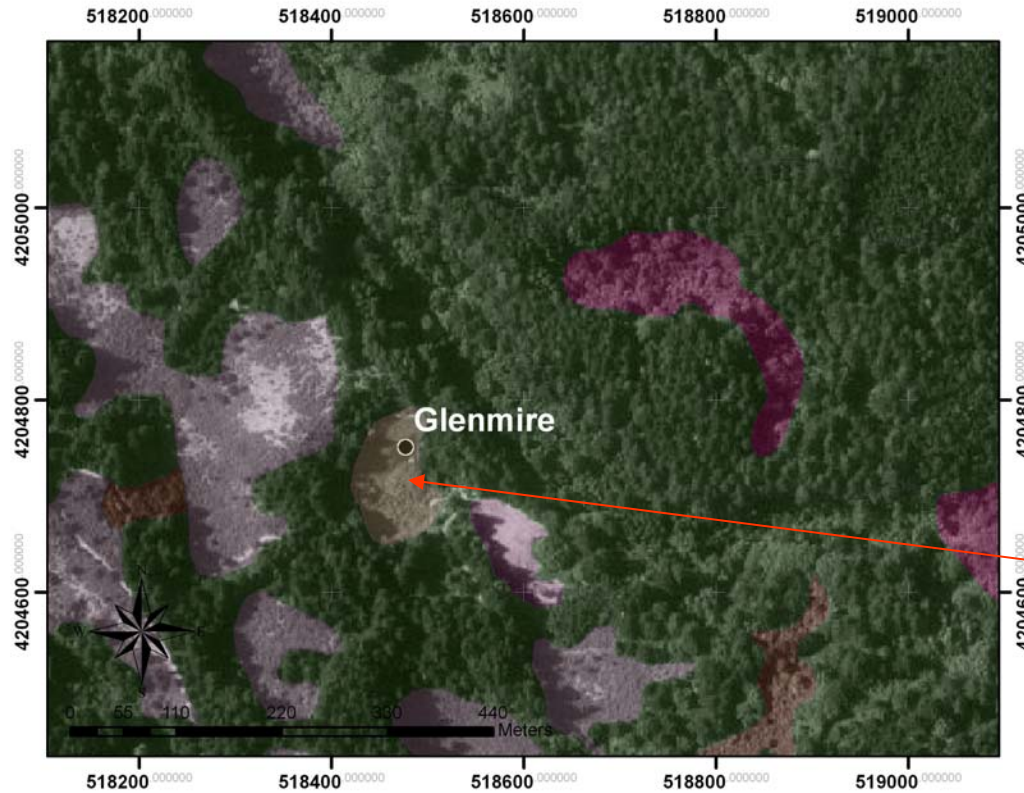


Glenmire



- 167 m above sea level
- Wetland NW of Glen Campground
- Closed Douglas-fir forest with California bay and oak
- Part of the Shafter Ranches, South End Tract (Livingston 1994). By 1879 a thriving dairy farm
- Cored in 30 cm of water

Glenmire









Legend

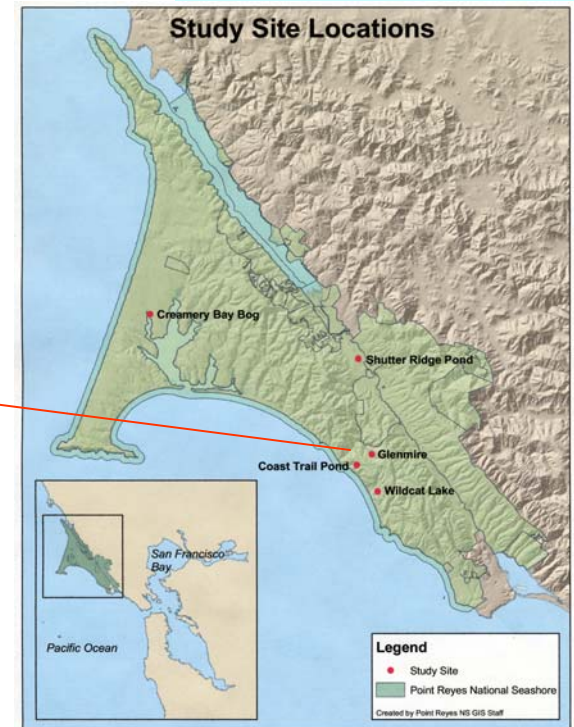
- Core Site

Coordinate System:
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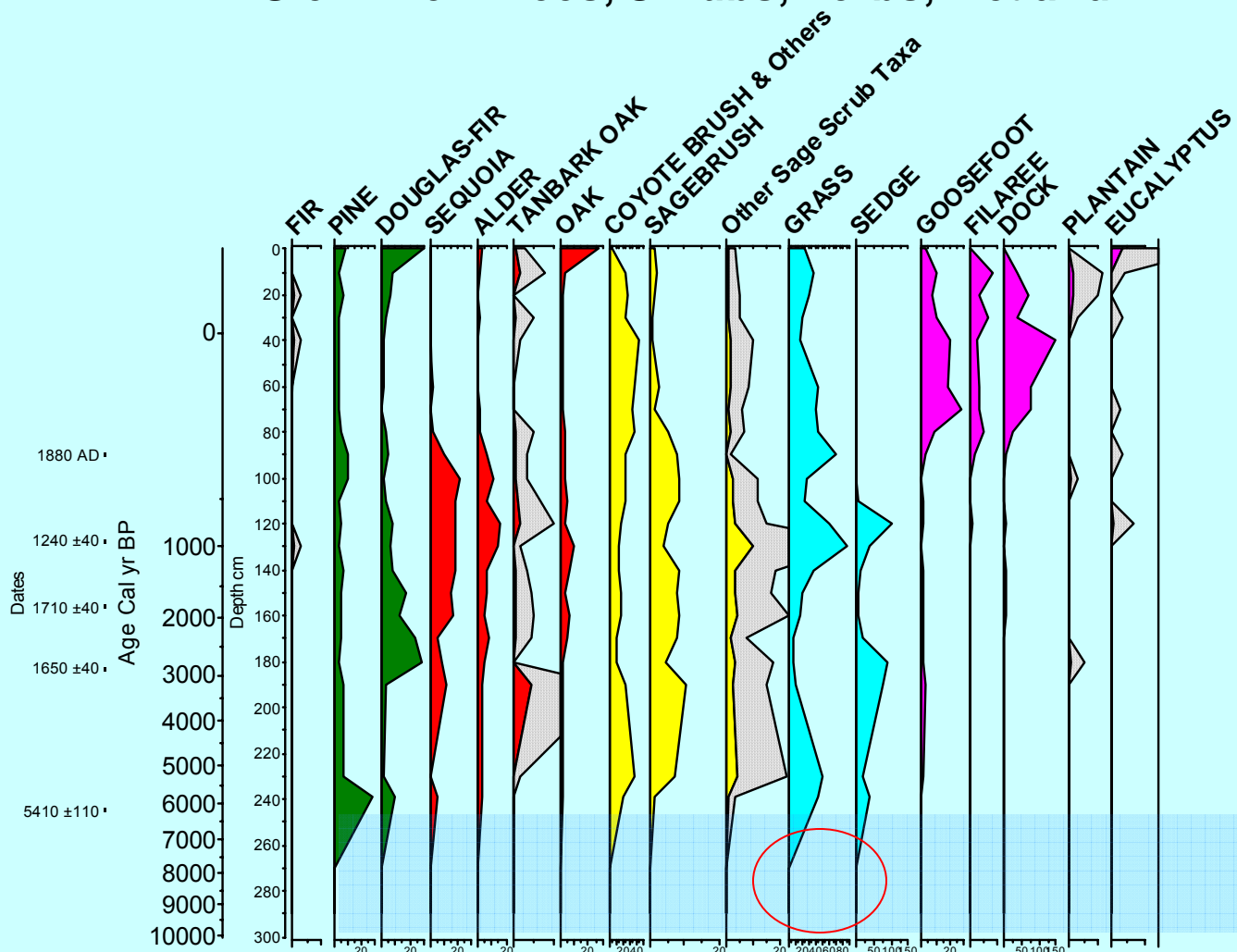
Point Reyes National Seashore Vegetation Map

ALLIANCE

- | | |
|--|--|
|  Bulrush - Cattail - Spikerush Marsh Mapping Unit |  Coyote Brush |
|  California Bay |  Douglas-fir |
|  Coffeeberry |  Rush |



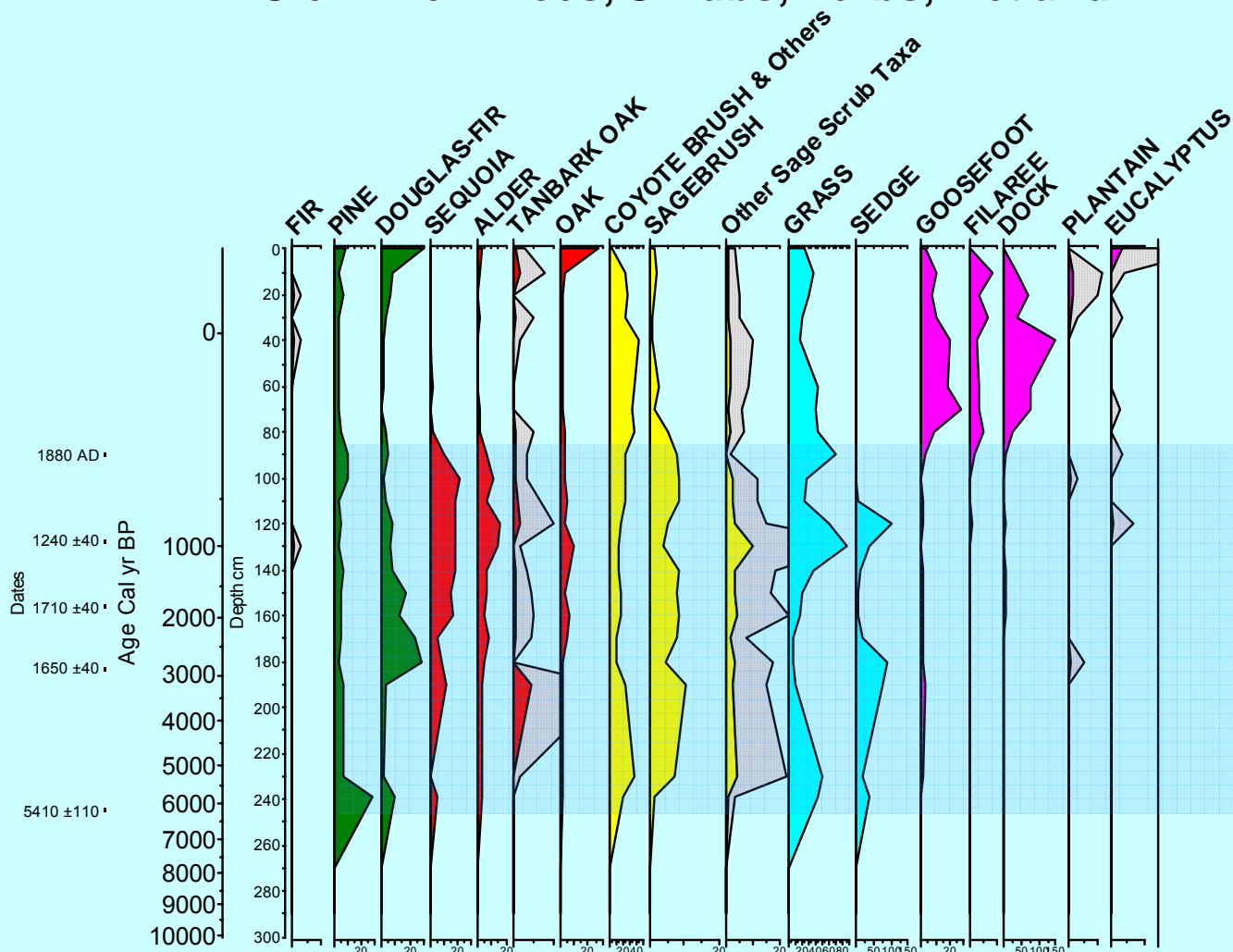
Glenmire - Trees, Shrubs, Herbs, Wetland



Pond Dry



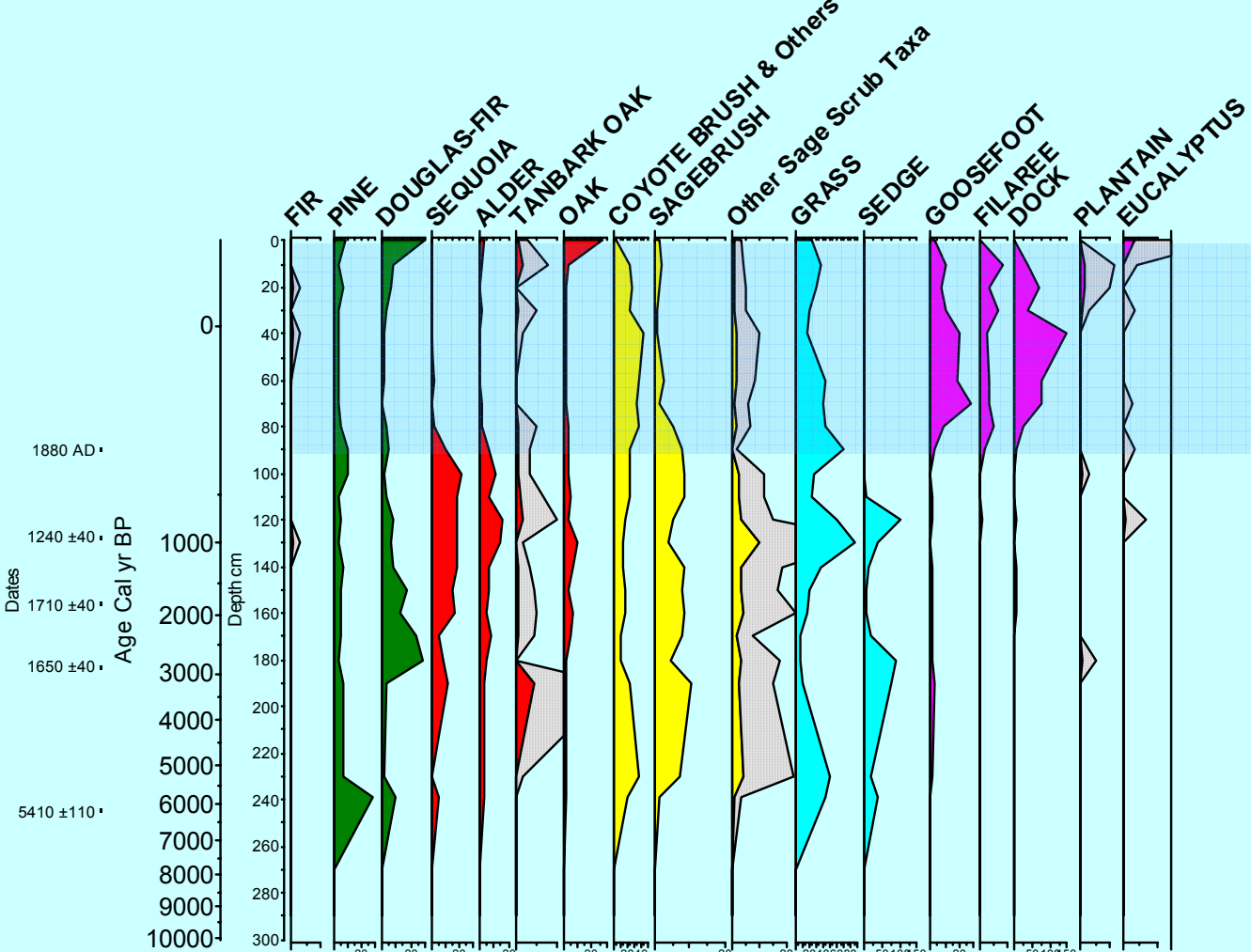
Glenmire - Trees, Shrubs, Herbs, Wetland



Mixed Conifer and
Hardwood Forest
w/ Sage Scrub



Glenmire - Trees, Shrubs, Herbs, Wetland



Historic Period

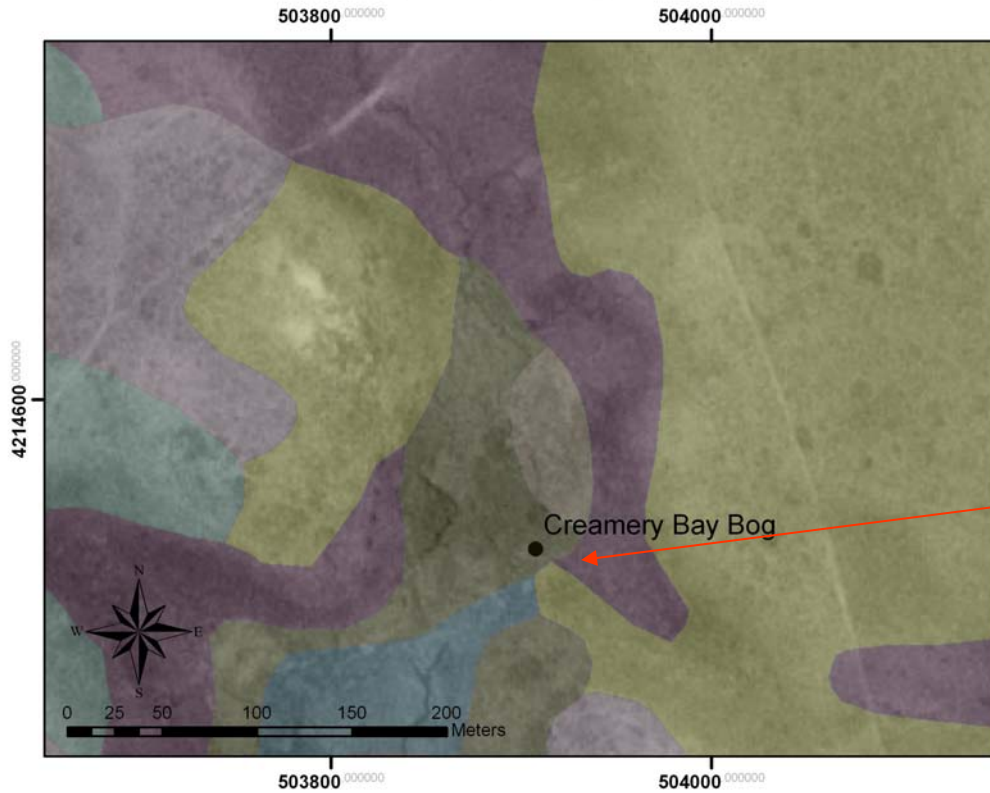


Creamery Bay Bog



- 6 m above sea level
- At the head of Creamery Bay
- Site of “K” Ranch dairy farm
- Oldest ranch site on the Point (Livingston 1994)
- Presently the site is a wet meadow

Creamery Bay Bog



Legend

- Core Site

Coordinate System:
 Projection - Universal Transverse Mercator (UTM)
 Datum - North American Datum of 1983 (NAD 83)
 Zone - 10 North

Point Reyes National Seashore Vegetation Map

ALLIANCE

- Bulrush - Cattail - Spikerush Marsh Mapping Unit
- California Annual Grassland Mapping Unit
- Coyote Brush

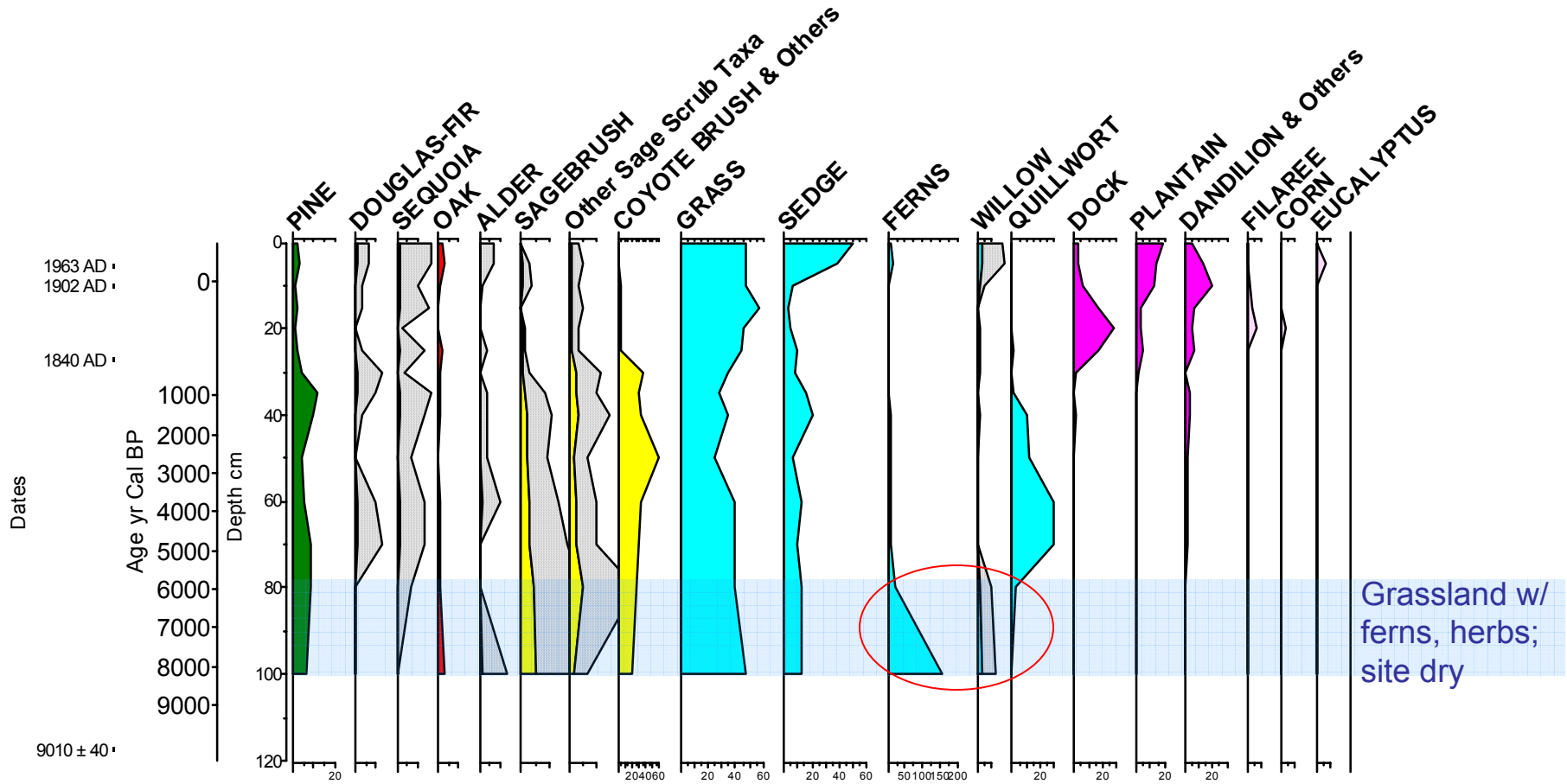
- Pickleweed
- Rush
- Saltgrass
- Tufted Hairgrass



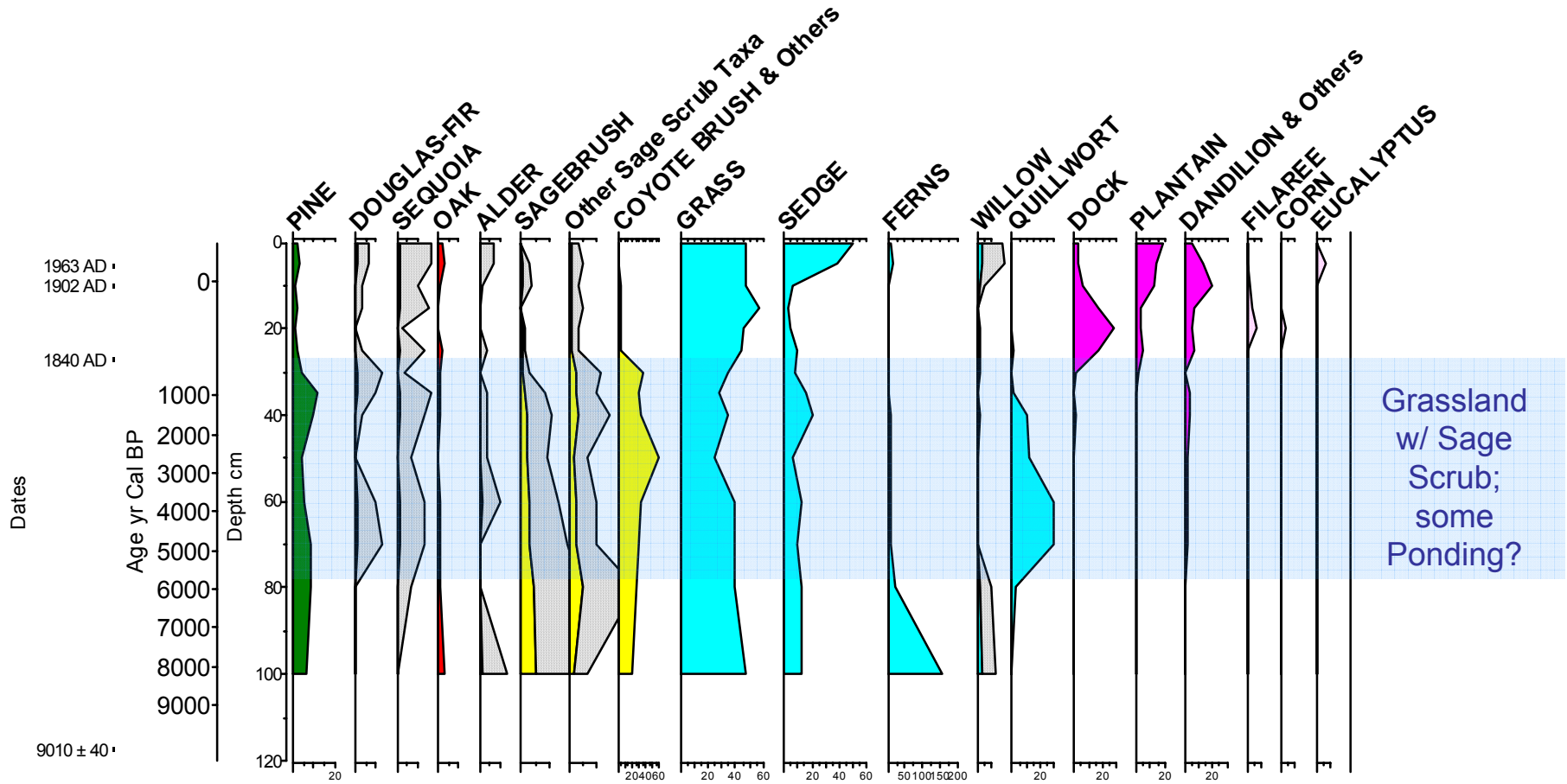
Legend

- Study Site
 - Point Reyes National Seashore
- Created by Point Reyes NS GIS Staff

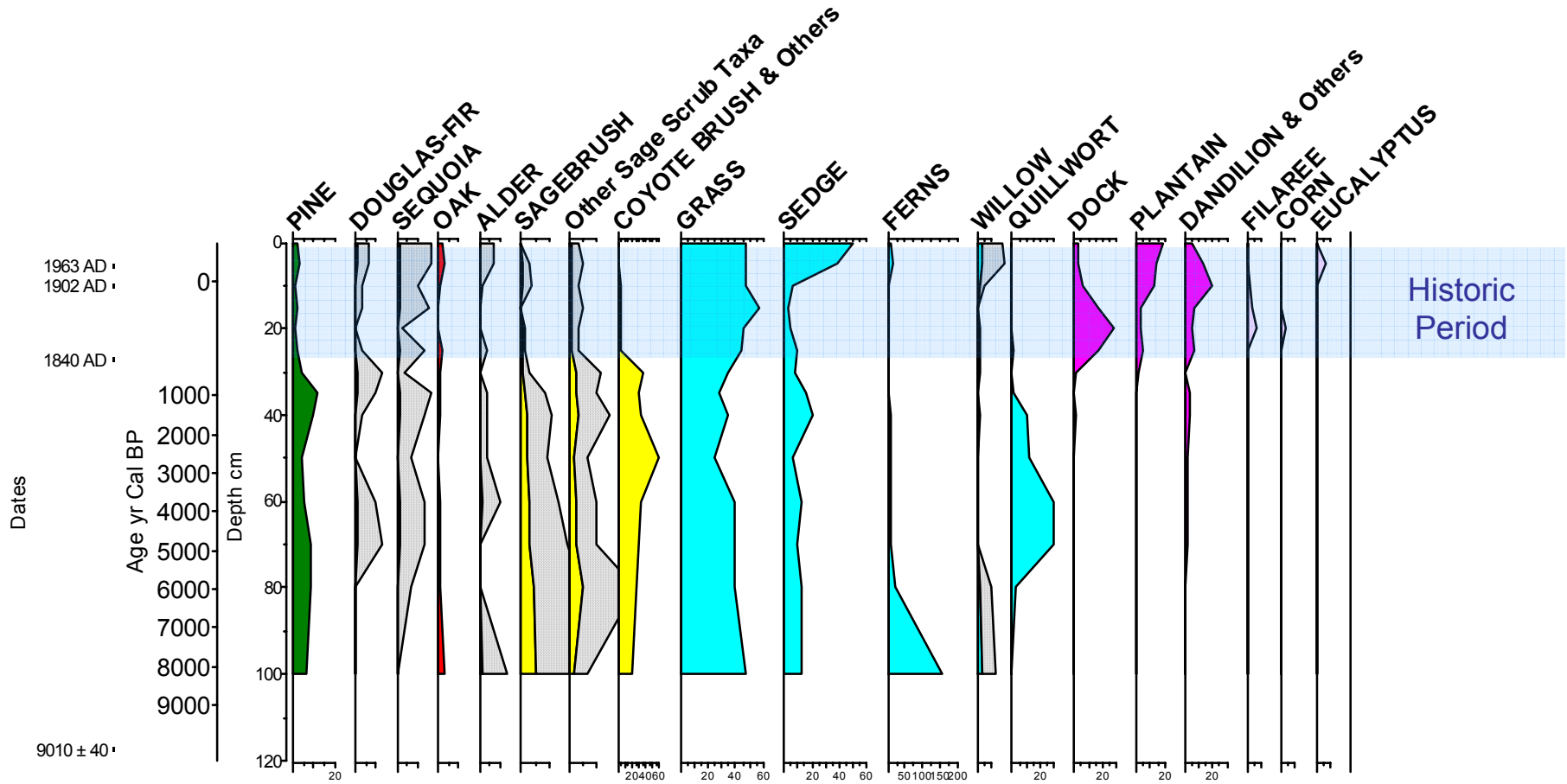
Creamery Bay Bog - Trees, Shrubs, Herbs, Wetland



Creamery Bay Bog - Trees, Shrubs, Herbs, Wetland



Creamery Bay Bog - Trees, Shrubs, Herbs, Wetland

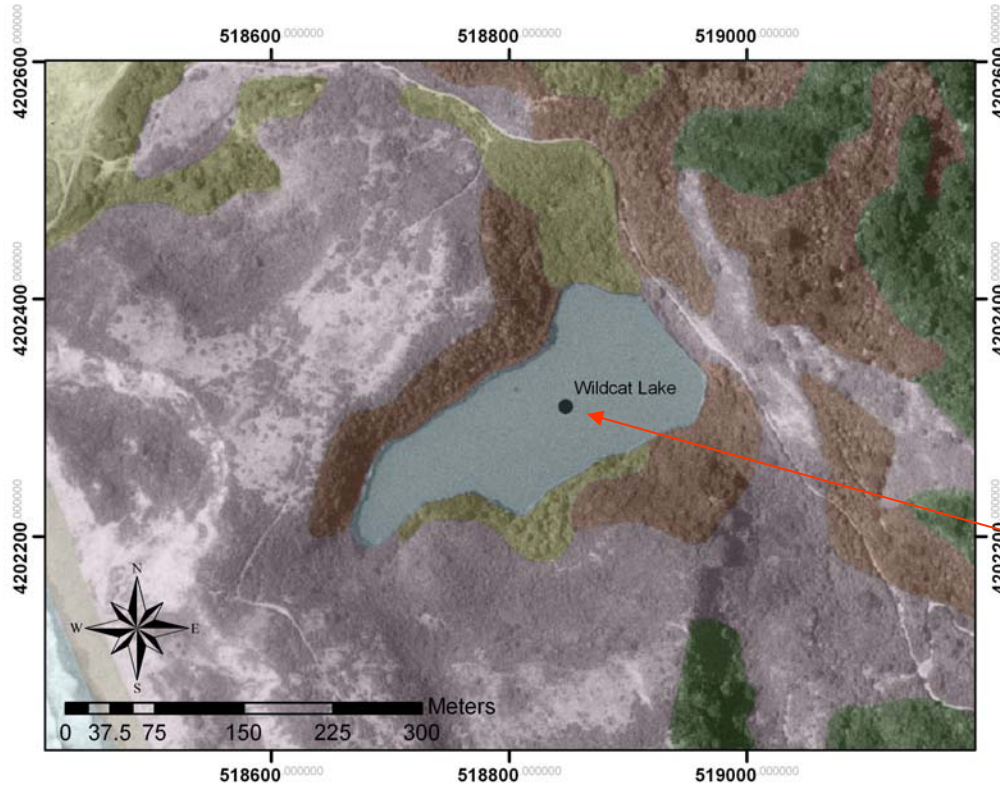


Wildcat Lake



- 62 m above sea level
- Sits on a complex landslide deposit
- Coastal scrub
- Area NW of lake (Wildcat Ranch) was occupied as early as 1858 (Livingston 1994)
- Cored in 8.75 m of water

Wildcat Lake



Legend

- Core Site

Coordinate System:
 Projection - Universal Transverse Mercator (UTM)
 Datum - North American Datum of 1983 (NAD 83)
 Zone - 10 North

Point Reyes National Seashore Vegetation Map

ALLIANCE

Arroyo Willow

Beaches or Mudflats

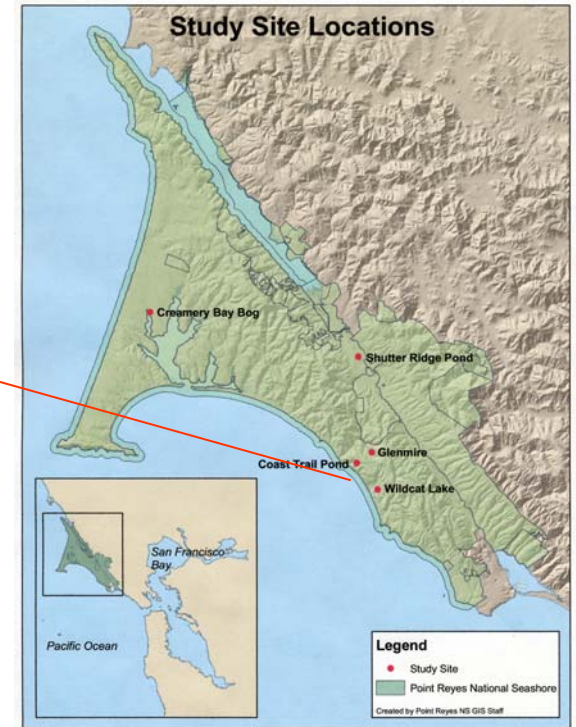
California Annual Grassland Mapping Unit

Coffeeberry

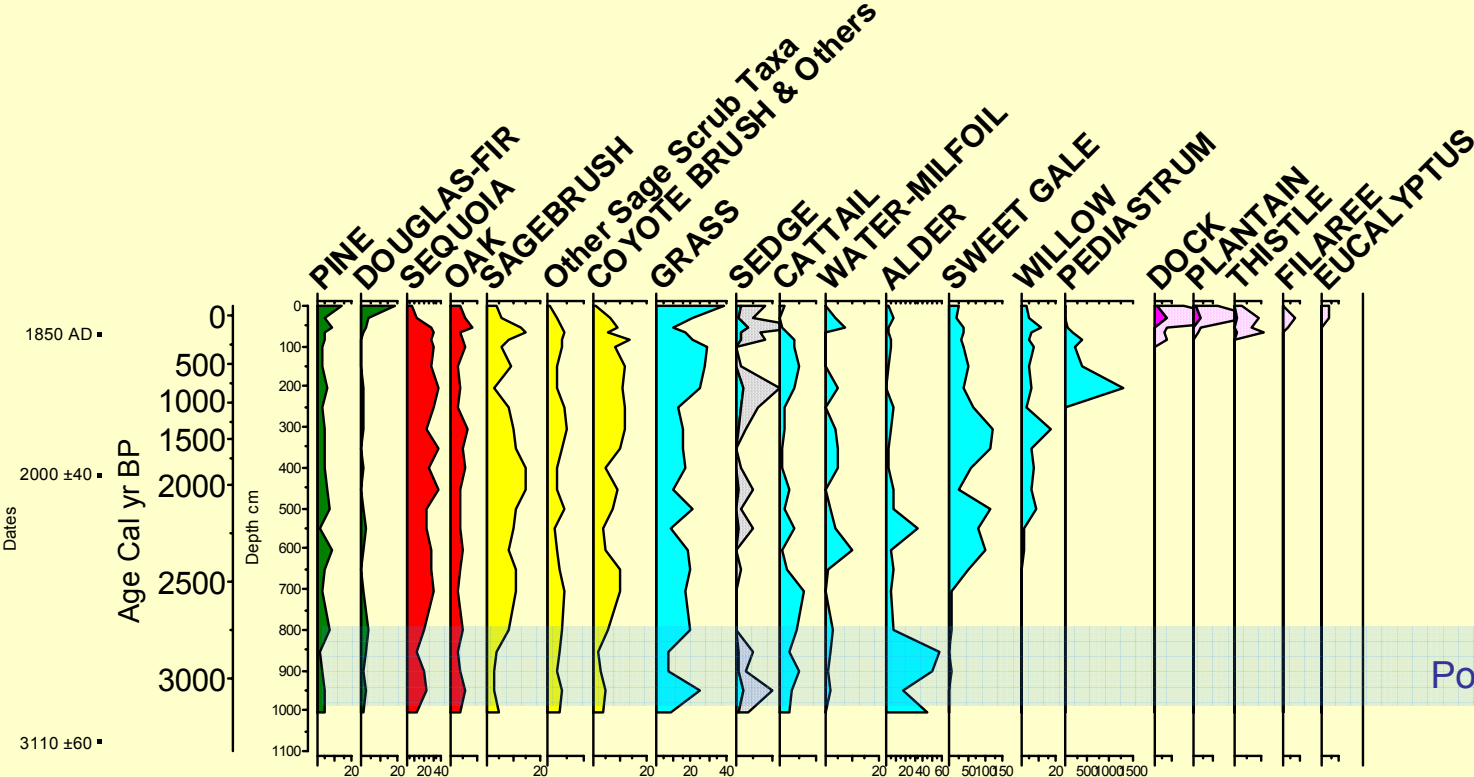
Coyote Brush

Douglas-fir

Water



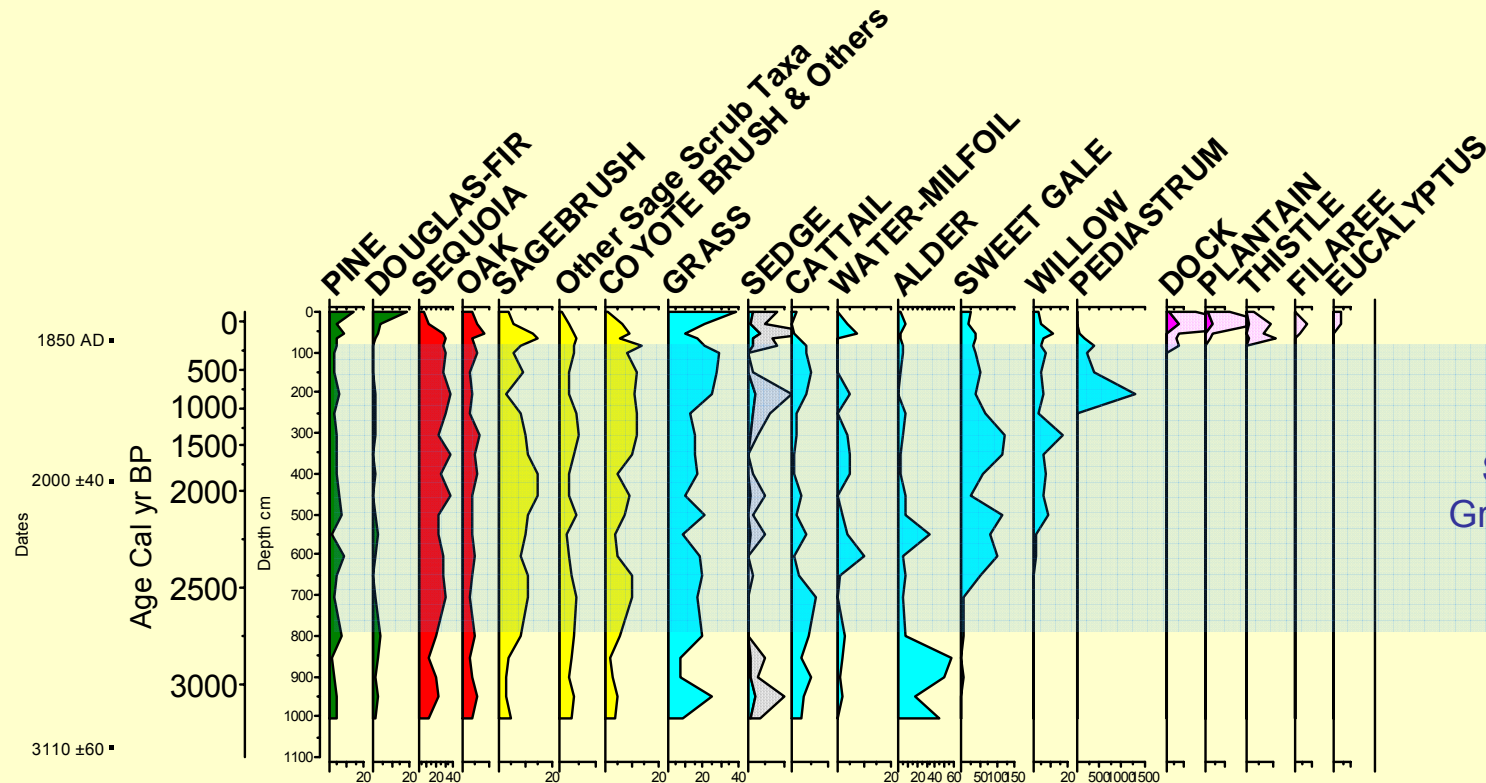
Wildcat Lake - Trees, Shrubs, Herbs, Wetland



Pond Forms; Alder



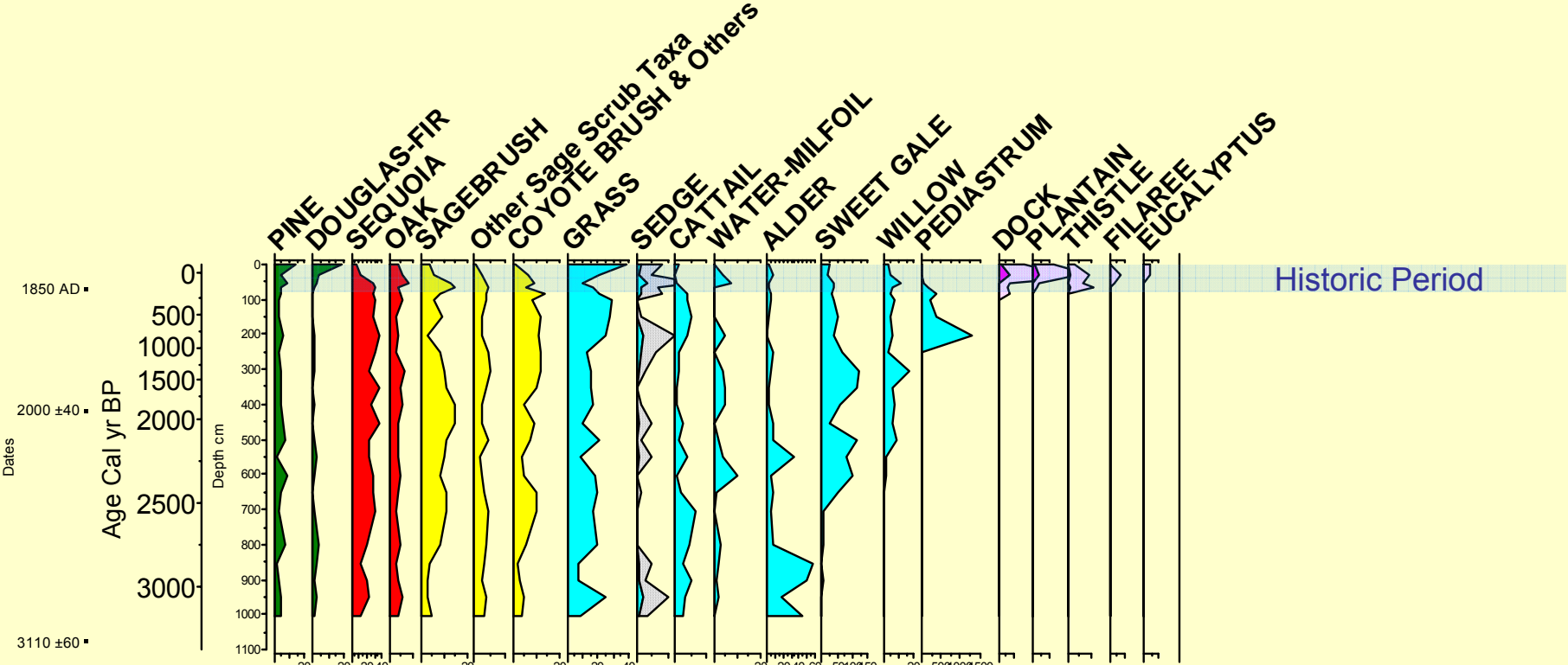
Wildcat Lake - Trees, Shrubs, Herbs, Wetland



Coastal Sage
Scrub w/ minor
Grassland & Mixed
Forest



Wildcat Lake - Trees, Shrubs, Herbs, Wetland

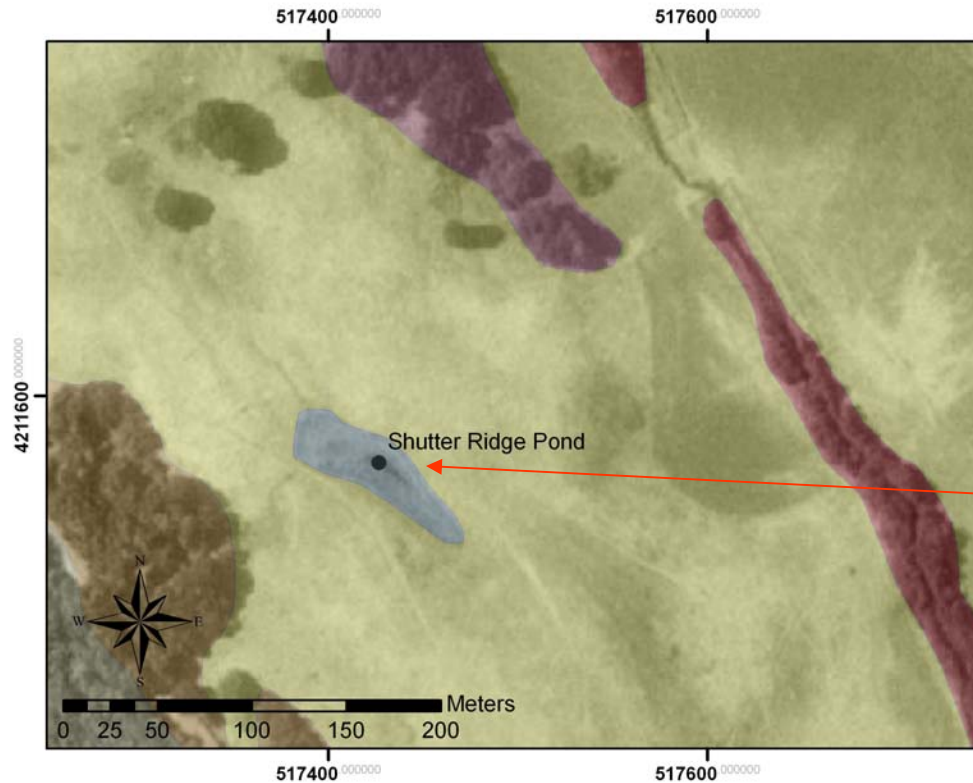


Shutter Ridge Pond



- 35 m above sea level
- In California annual grassland
- Situated on a push ridge
- Site originally settled by Garcia family
- Probably became part of Shafter's "W" Ranch in the 1860's (Livingston 1994)
- 1 m deep, but dries out

Shutter Ridge Pond



Legend

- Core Site

Coordinate System:
 Projection - Universal Transverse Mercator (UTM)
 Datum - North American Datum of 1983 (NAD 83)
 Zone - 10 North

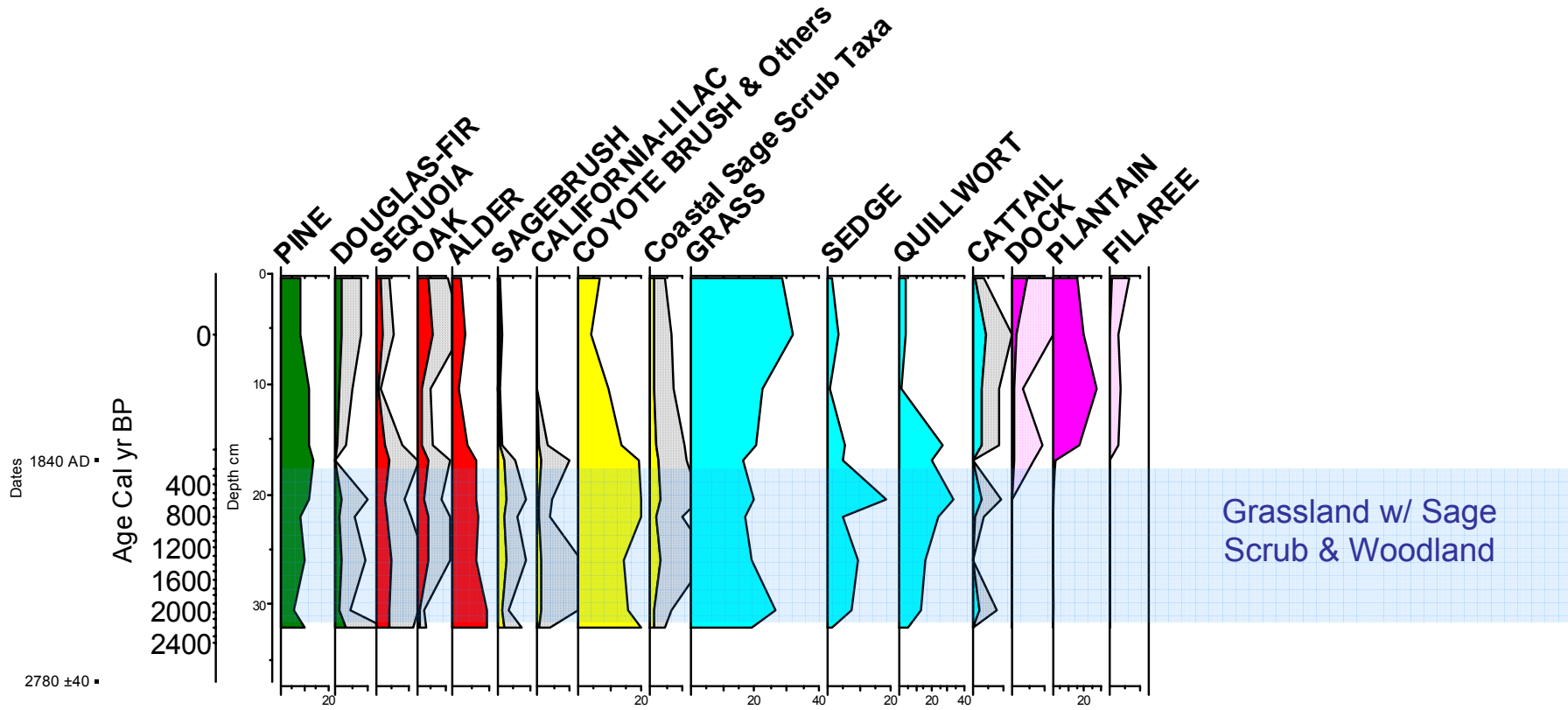
Point Reyes National Seashore Vegetation Map

ALLIANCE

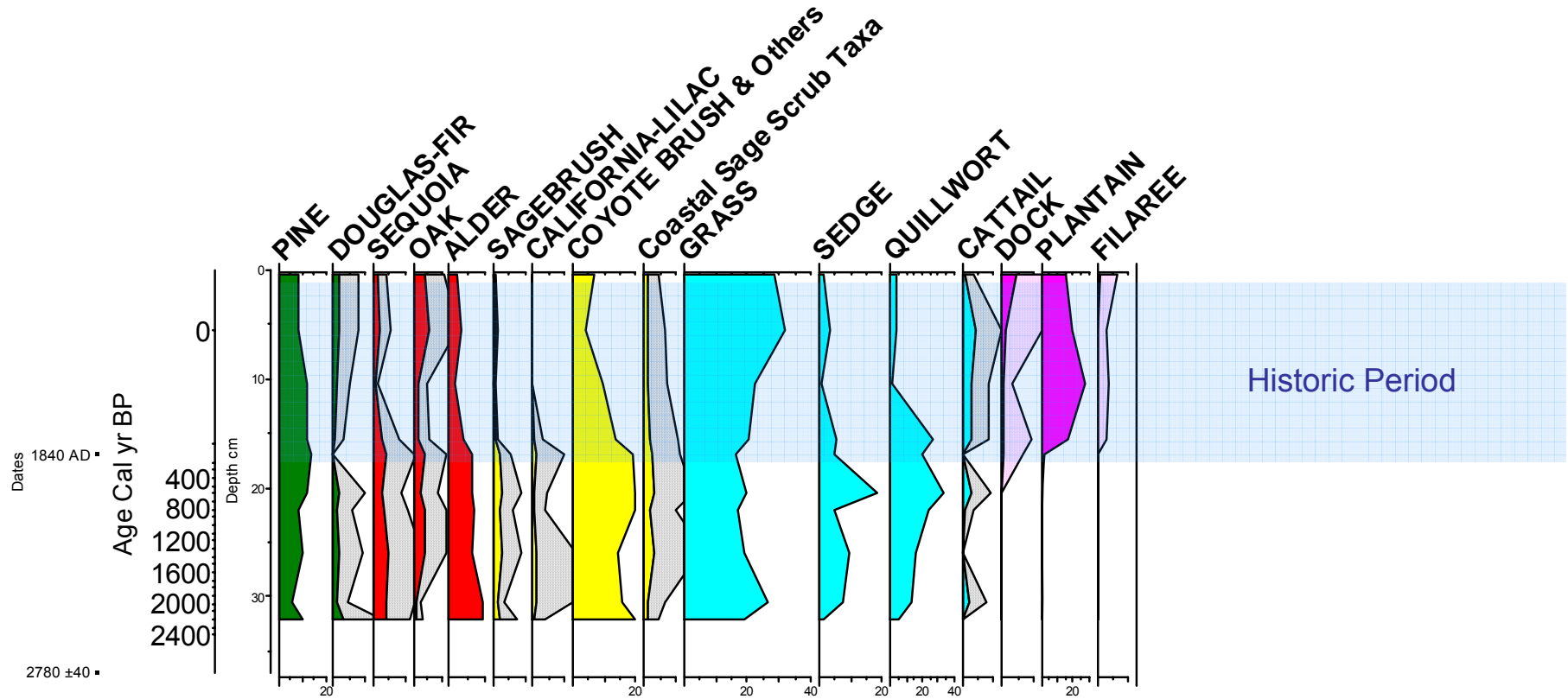
- | | |
|--|--|
|  Arroyo Willow |  Coast Live Oak |
|  California Annual Grassland Mapping Unit |  Red Alder |
|  California Bay |  Water |

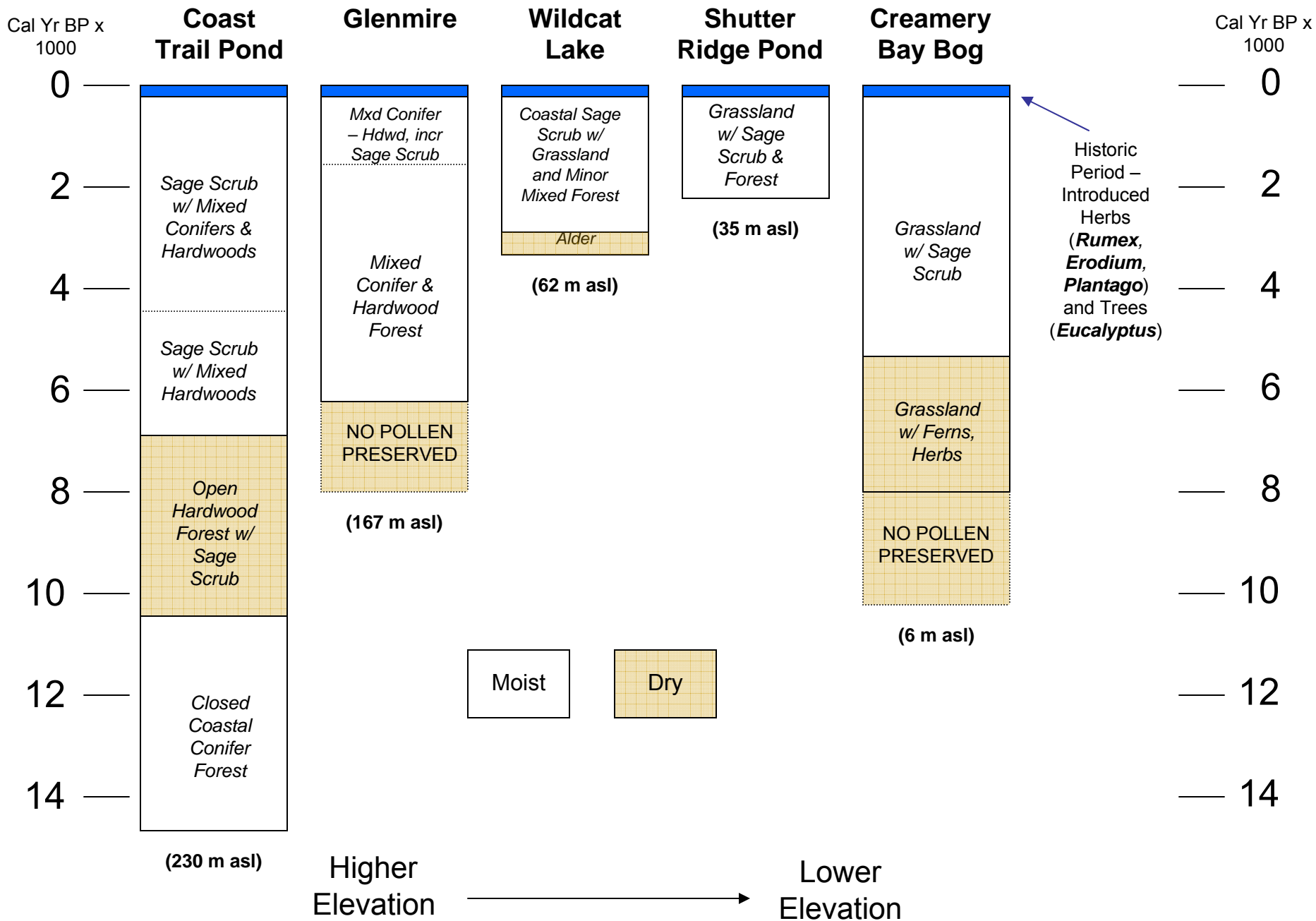


Shutter Ridge Pond - Trees, Shrubs, Herbs, Wetland

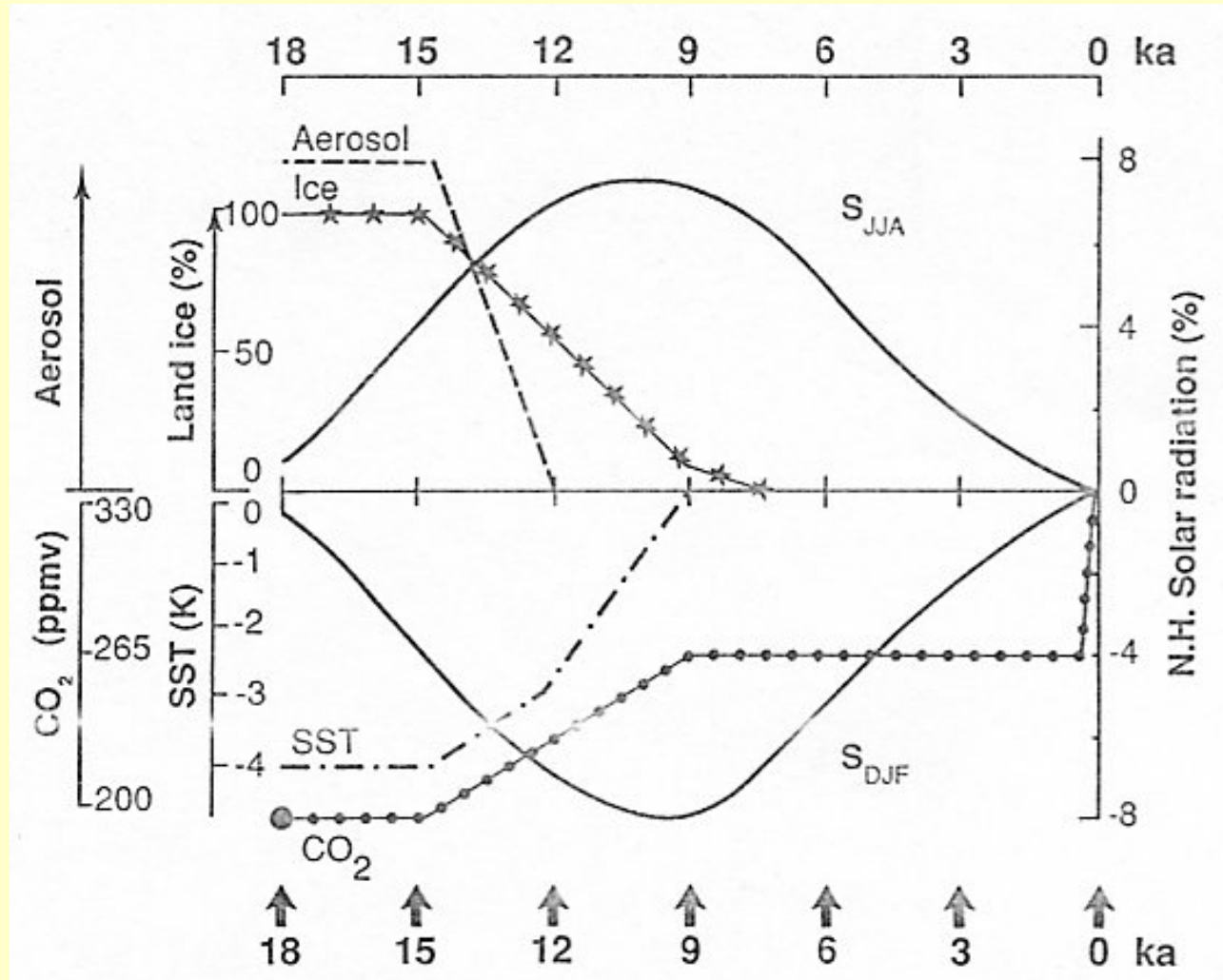


Shutter Ridge Pond - Trees, Shrubs, Herbs, Wetland

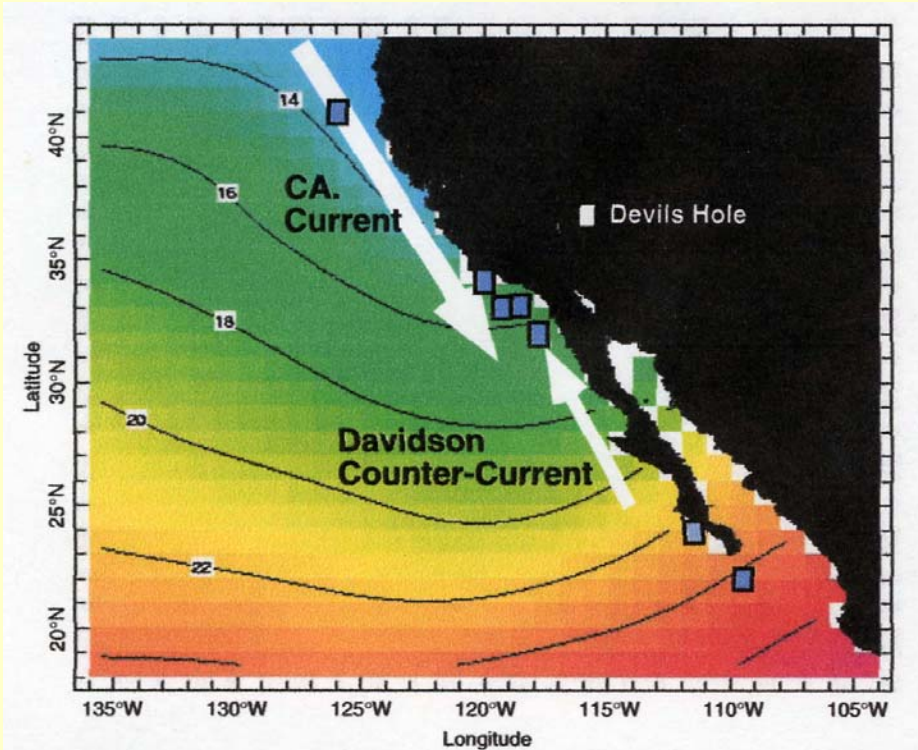




Solar Maximum in early Holocene

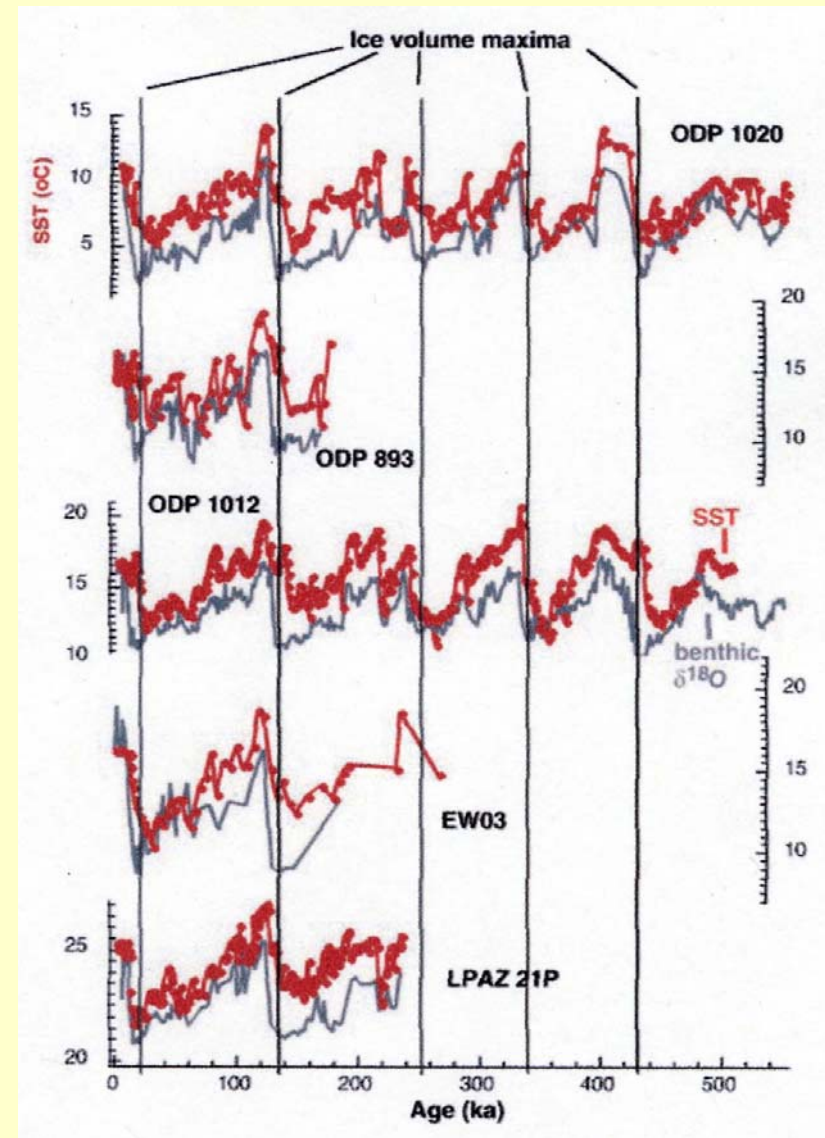


Changes In SST

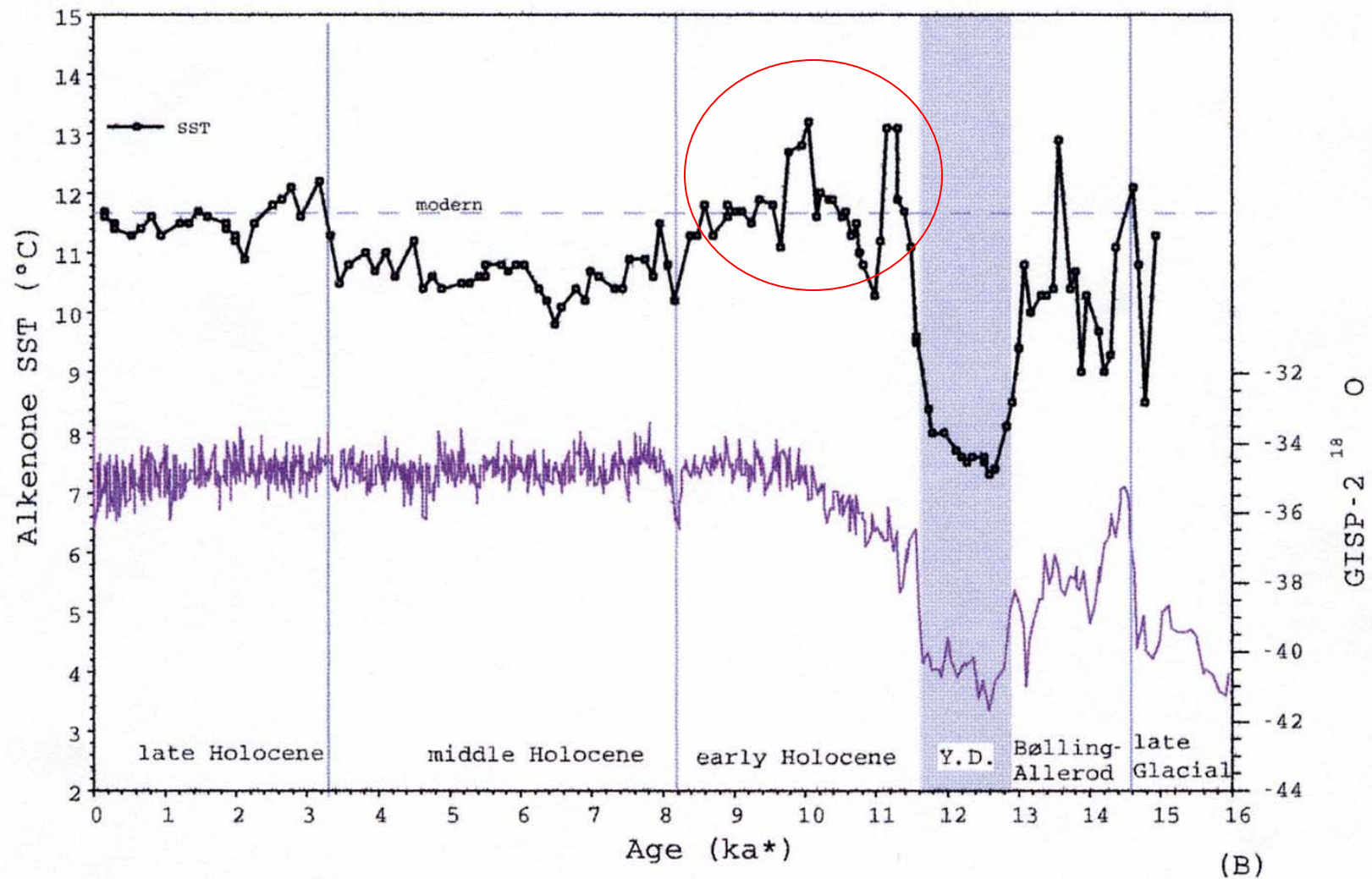


Herbert et al (2001)

[also Barron et al 2003 & Lyle et al (2001)]



CA Sea Surface Temp & $\delta^{18}\text{O}$



Barron et al. (2003)

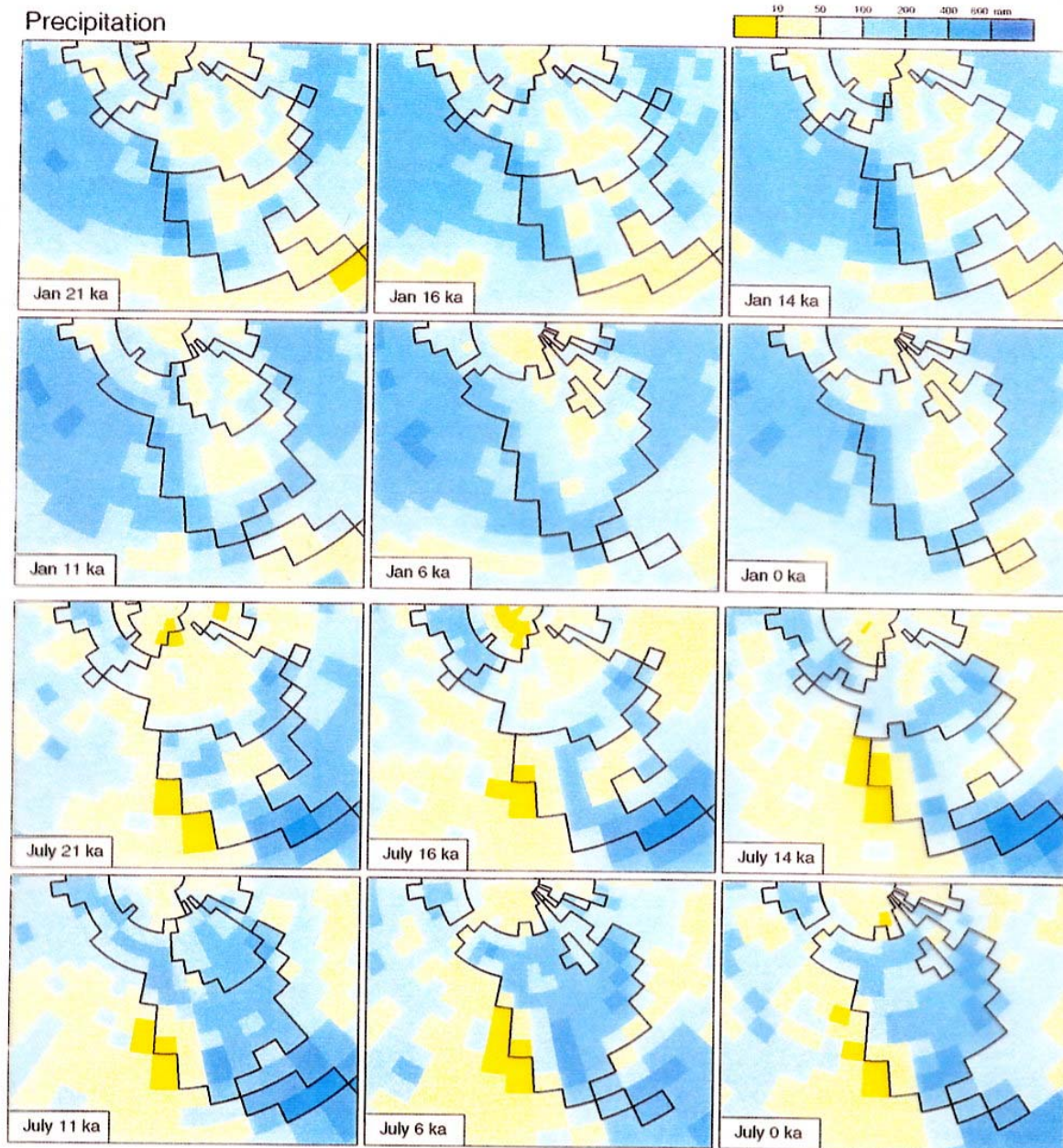
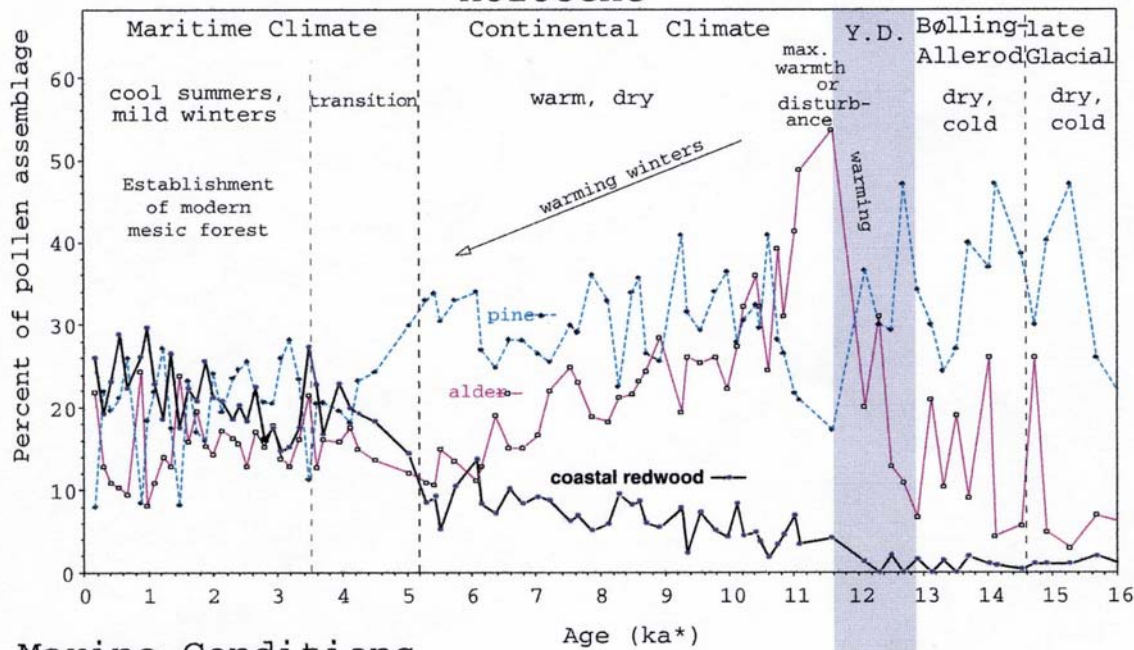


FIG. 4. Simulated January and July monthly total precipitation (mm).

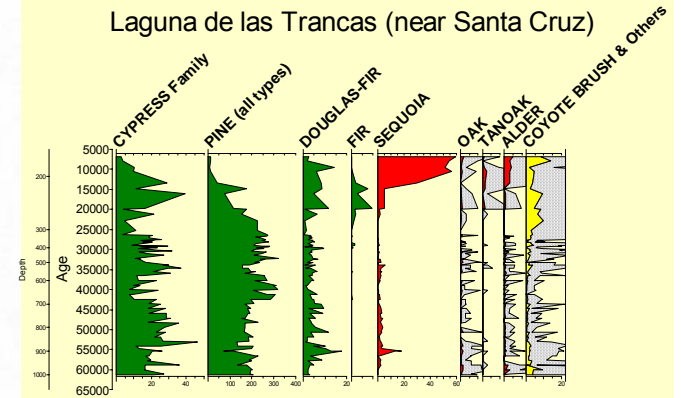
Simulated
Precipitation
for
Jan & July,
21K, 16K,
14K, 11K, 6K
& Present

Bartlein et al.,
1998

Continental Conditions Holocene

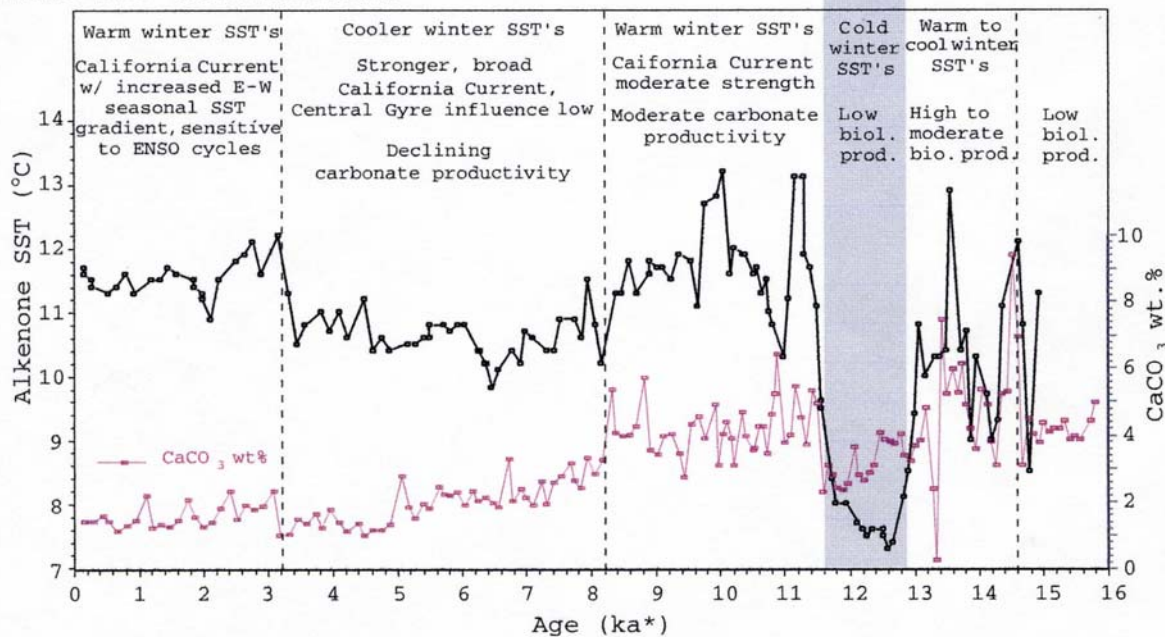


Laguna de las Trancas (near Santa Cruz)



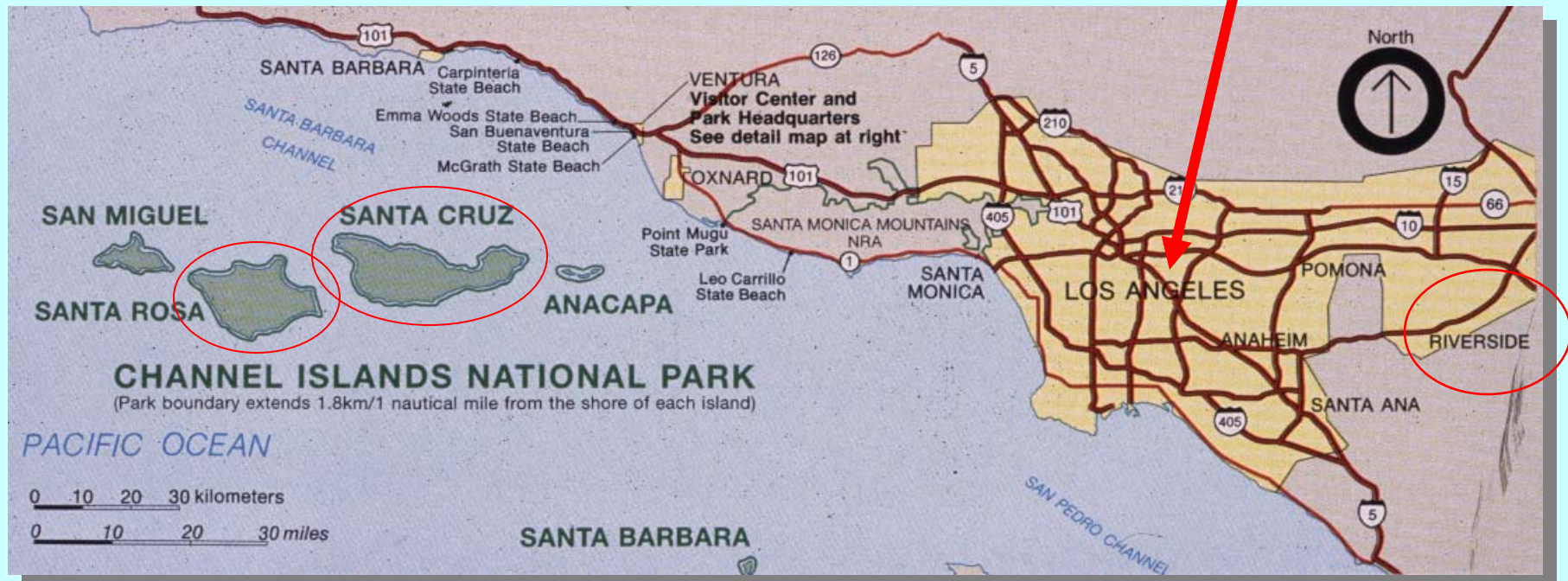
Anderson et al, unpublished

Marine Conditions

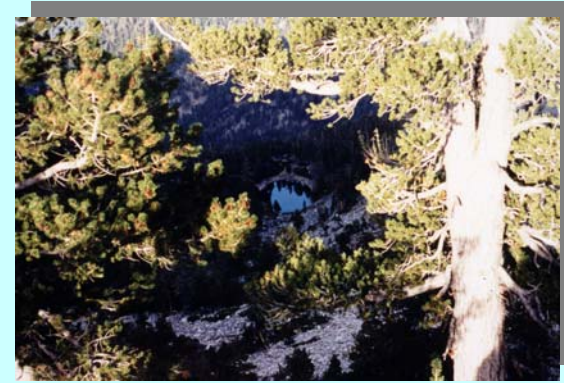


Barron et al.
(2003)

Northern Channel Islands & Inland Empire



Cañada de los Sauces (SCI)



Dollar Lake (SBCo)

Southern California Sites



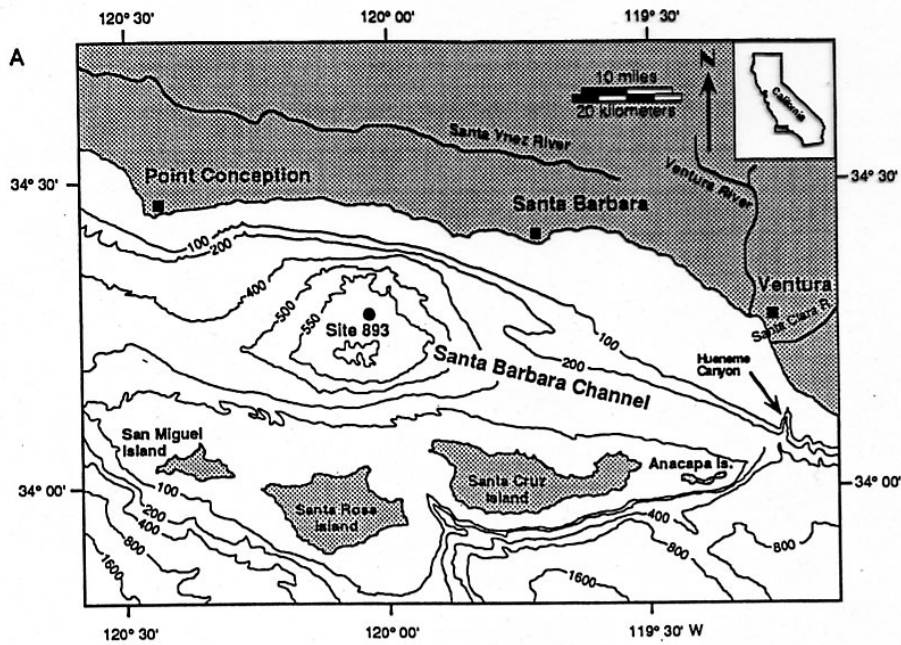
Mystic Lake (RiversideCo)

Soledad Pond (SRI)



Abalone Rocks Marsh (SRI)

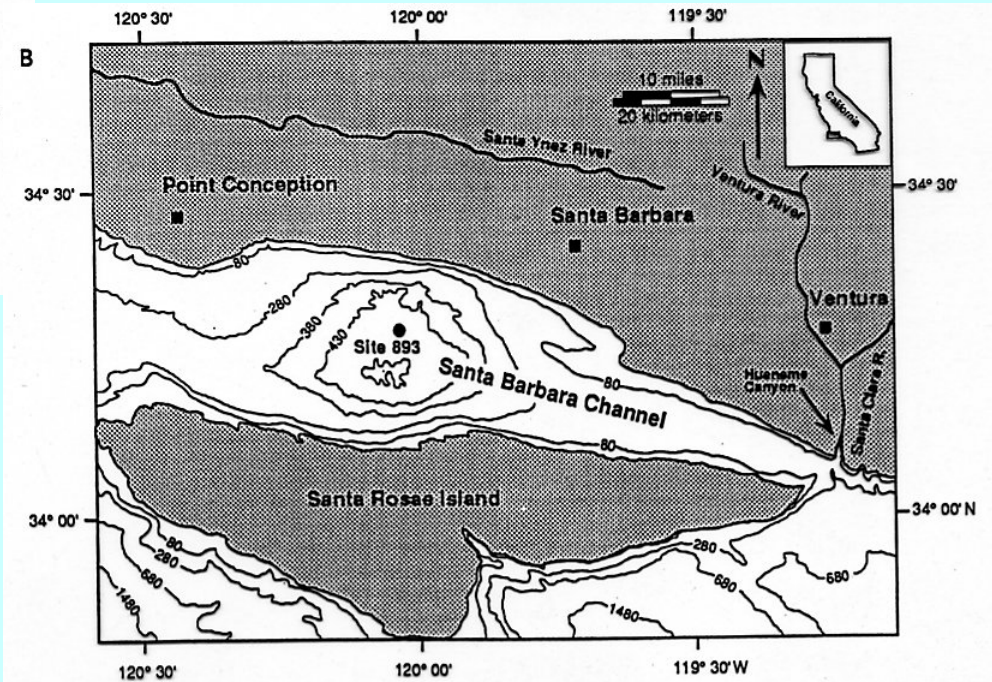
Santa Rosae Island

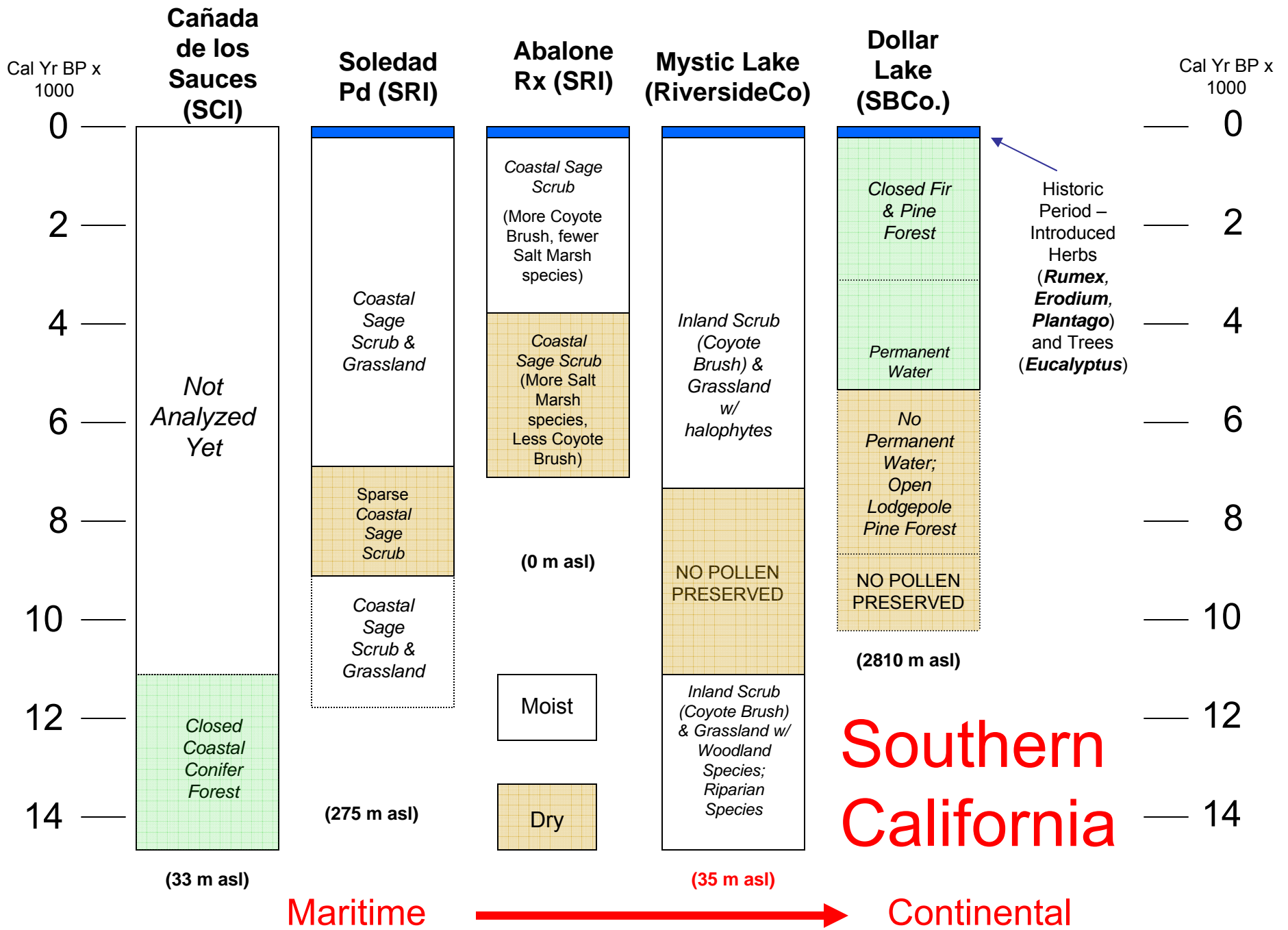


Modern Coastline

Ingram & Kennett 1995

Pleistocene Coastline





Fire History Studies

- Critical to our understanding of the centennial and millennial-scale fire history is the history of fire over the last two centuries
- Little was known about the pre-Historic fire regimes on the Point Reyes Peninsula until the work of Finney (1990) and Brown et al. (1999)

Fire History Studies

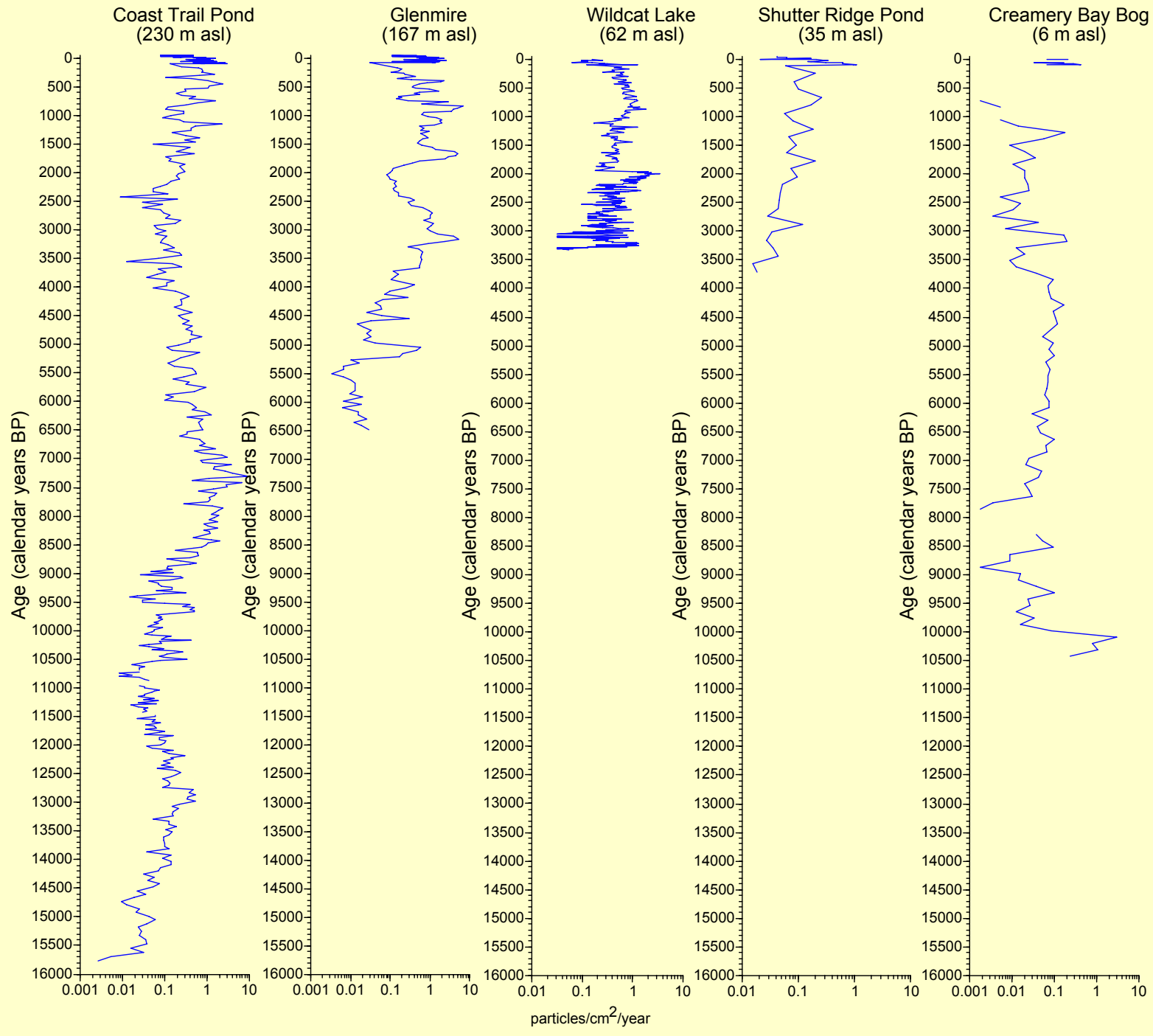
- **Brown et al. (1999)**
 - Limatour Road and Five Brooks sites
 - periodic fire from the 18th century until ca. 1905 (Five Brooks) or 1918 AD (Limatour Road)
 - Pre-settlement Mean Fire Intervals (MFI) [early 1800's to ca. 1900 AD] **7.7 to 8.5 years** – characteristic of a surface fire regime

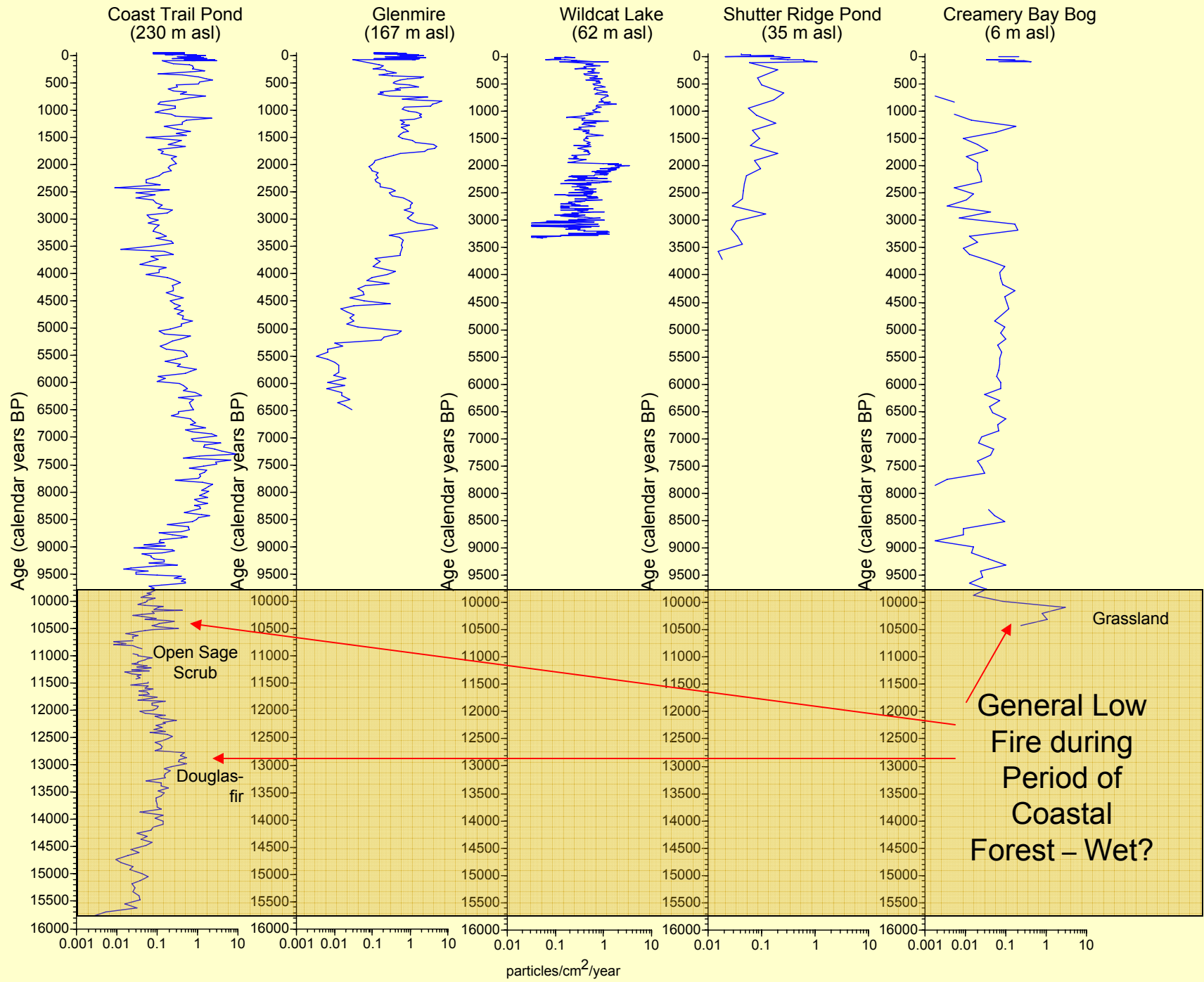
Fire History Studies

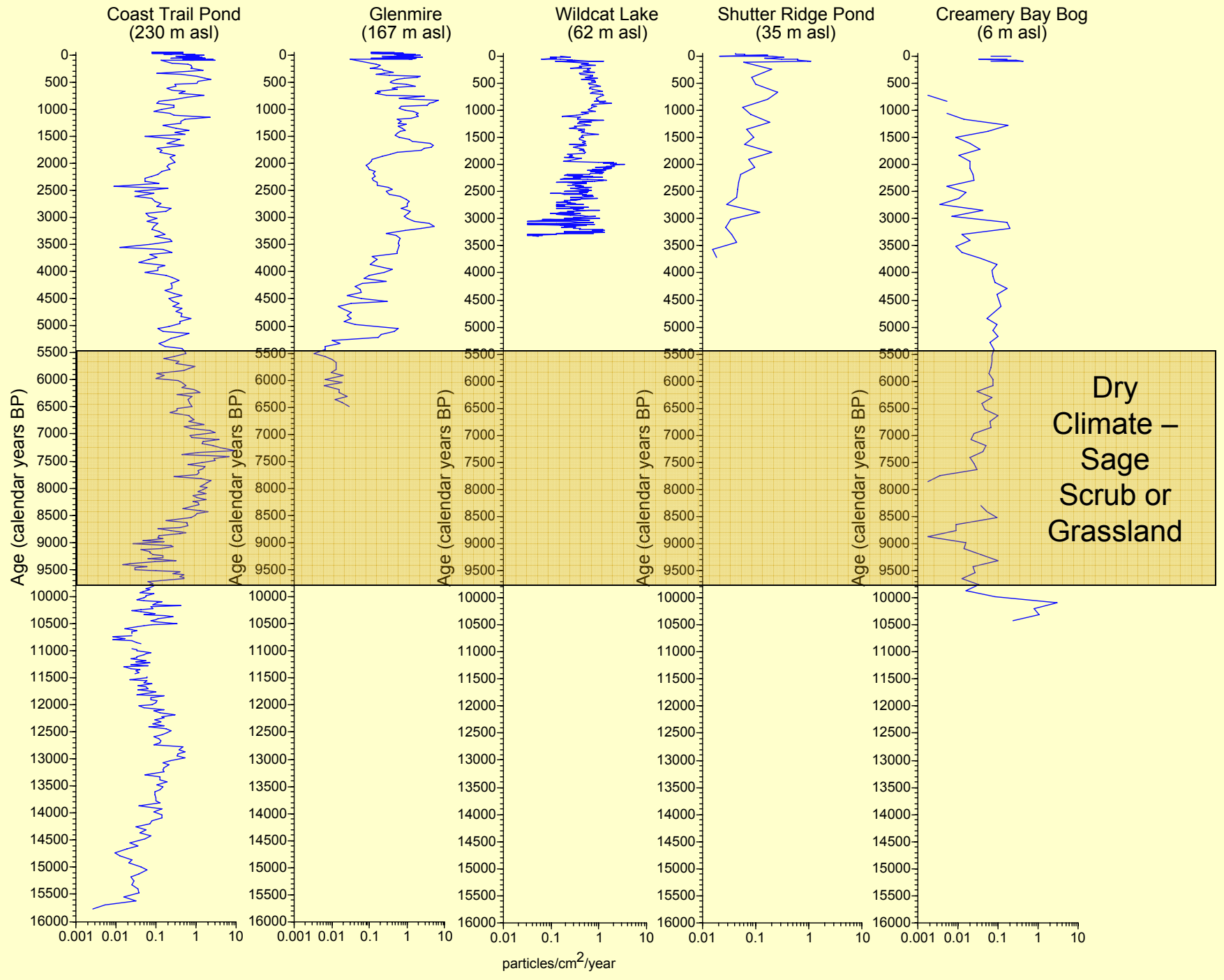
- **Finney (1990)**
 - Bolinas Ridge and the Kent Lake region
 - Pre-settlement MFI 7.5 years for small fires, and < 2 years for larger fires
 - Settlement MFI [last half of the 20th century] was an order of magnitude longer

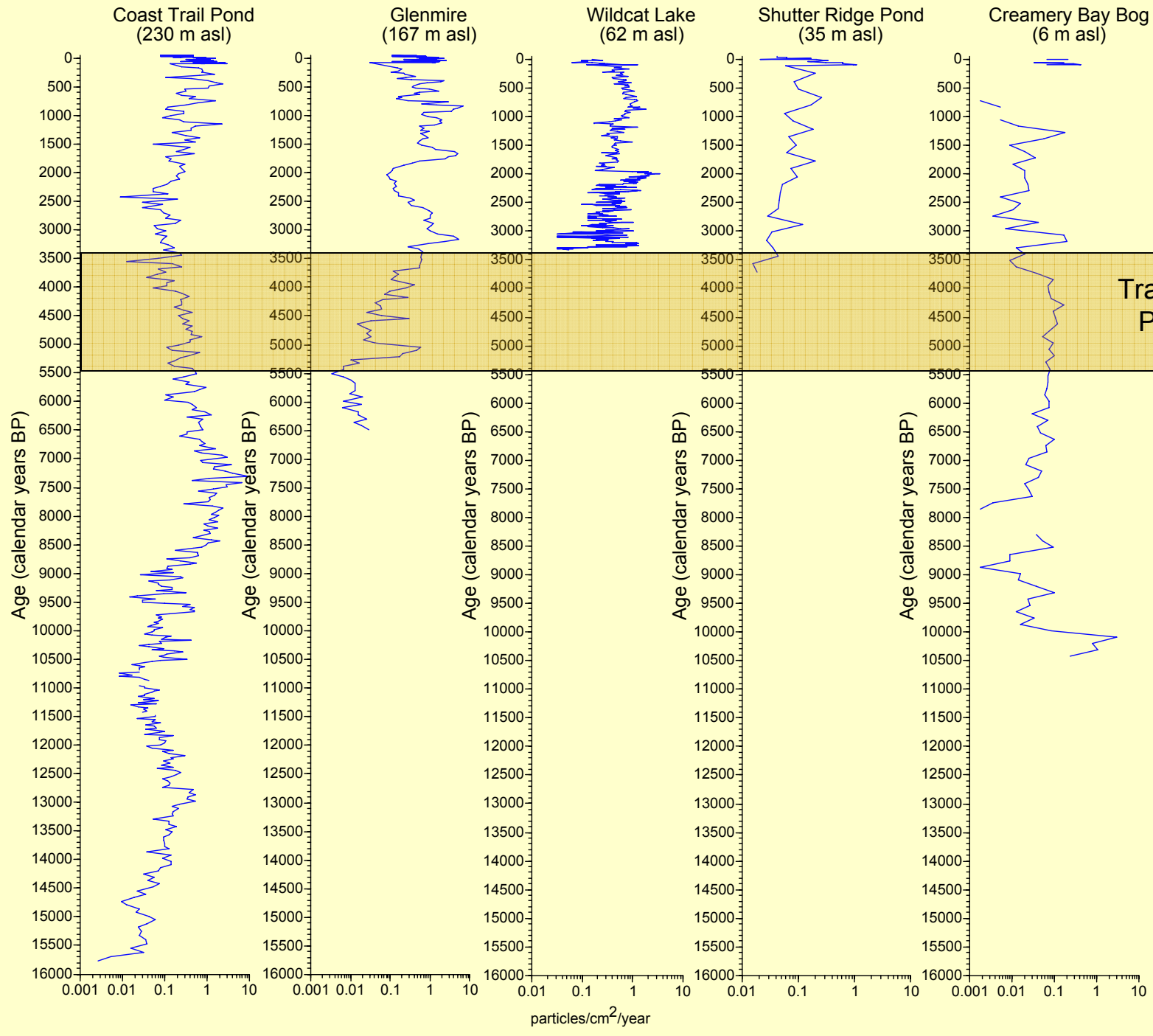
Fire History Studies

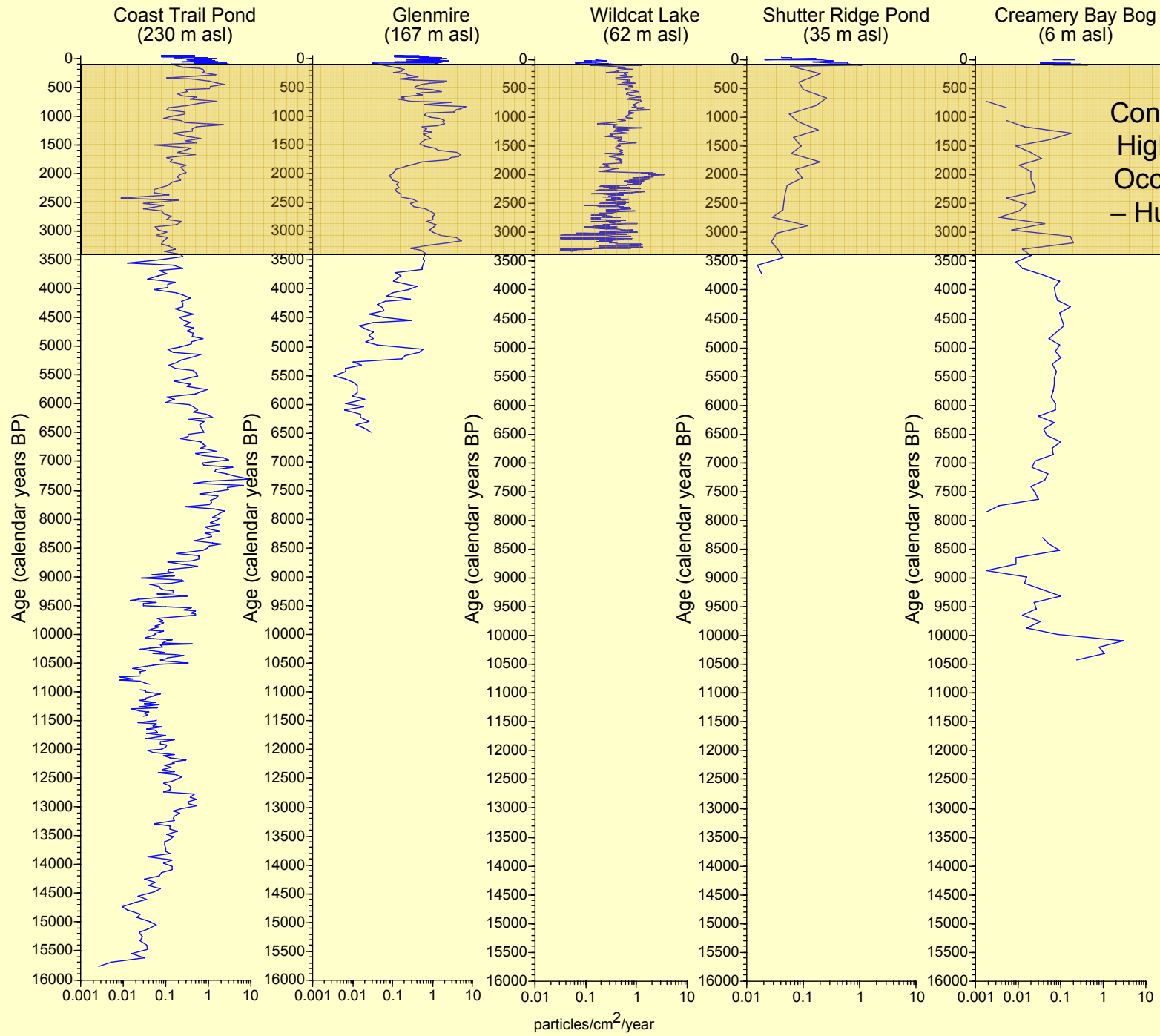
- Change in fire regime in 20th century due to cessation of surface fire regime (Finney 1990; Brown et al. 1999) that probably existed during the pre-Historic period.





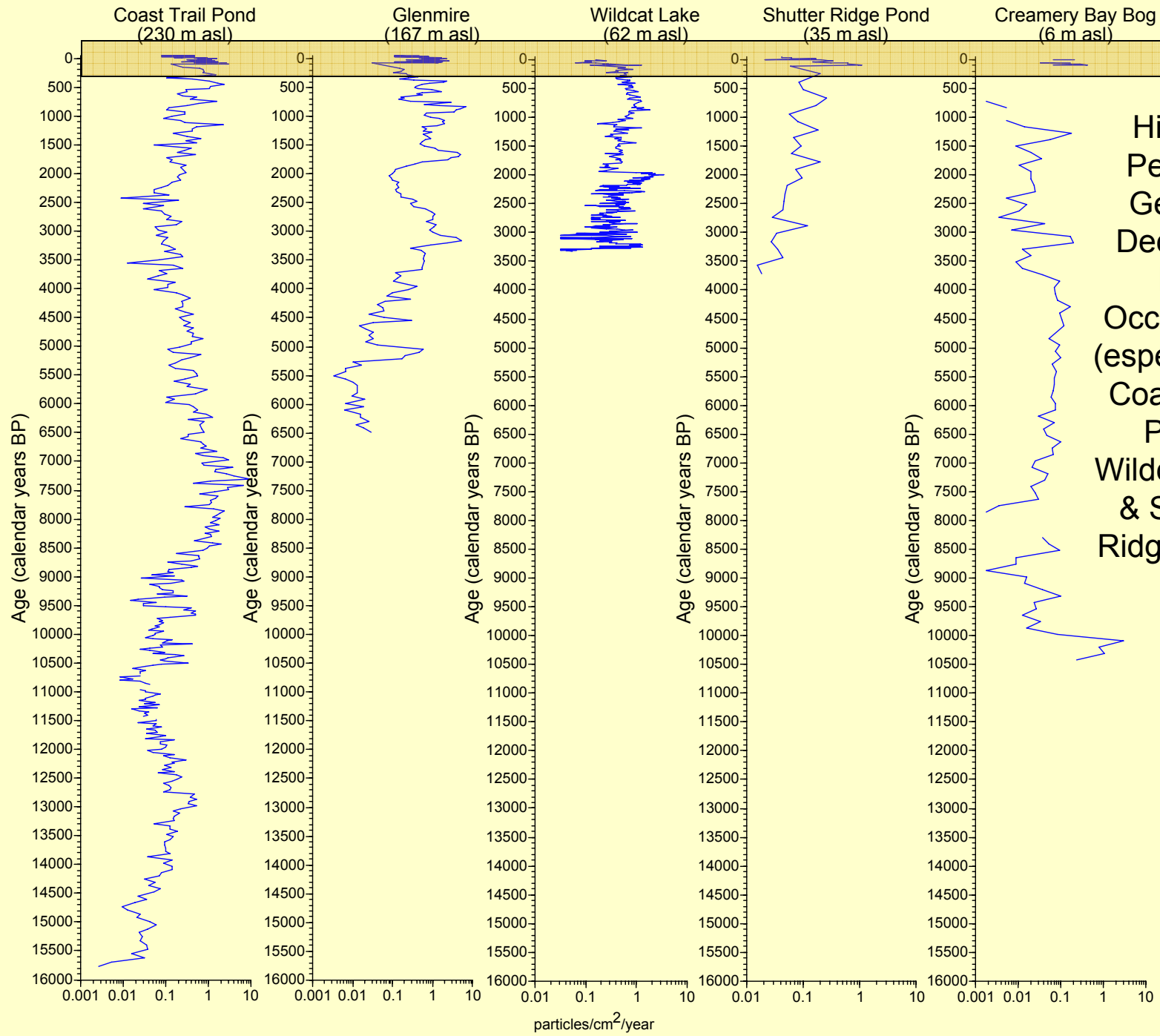






Why Synchronous Increase ?

- Climate changes → wetter conditions, more biomass
- Human activities
 - Native American burning ethnographies
 - Human habitation of Peninsula by coastal Miwok by 5000 years ago
 - ^{14}C dates on archaeological sites on and near Point Reyes increases after ca. 3500 years ago suggesting expanding human population
 - These data are not conclusive of Human Burning, but are at least suggestive



Summary – General Considerations

- A complex relationship between vegetation, climate, human settlement & fire occurrence
 - Abundant charcoal produced, but conifer forest and sage scrub produced more charcoal than did grassland during the Holocene.
 - Climate affects the characteristics of each sedimentary basin – determining whether that basin will be perennially wet or periodically dry.
 - Local conditions, in turn, affect the local vegetation at each site.
 - Human activities can have a potentially large effect on both vegetation and fire history.

Summary – Vegetation Changes

- Closed coastal conifer forest until ca. 10,200 yr ago
- Driest Period commenced ca. 10,000 yr ago
- Early Holocene established Mixed forest &/or coastal sage scrub (most locales) and grassland (CBB)
- Still reasonably dry until ca. 6500 yr ago
- Modern vegetation established during late Holocene
- Greatest vegetation change is in Historic Period

Summary – Fire Histories

- 15k to 10 k – Generally low fire occurrence during period of coastal forest – Wet?
- 10k to 5.5 k - Early Holocene peak in fire activity – dry climate?
- 5.5 to 3.5 k – vegetation change and corresponding fire history adjustments
- 3.5 k to Historic times – general increase in fire, climate or humans?
- Human activities may have had entirely different effects on the fire regime at different times in the past
 - Native American populations potentially contributing to high fire frequencies
 - Euro-Americans causing fire to become more rare, but perhaps more destructive

Summary – General Considerations

- Many factors have been important in determining characteristics of vegetation and fire disturbance histories at Point Reyes.
- With increasing human impact on the landscape and our climate, retrospective studies are important
 - in understanding how modern vegetation communities came to be as they are today
 - as a reference for restoration of former habitats
 - as a baseline to determine the magnitude of future impact of humans.

Heartfelt Thanks to:

Douglas Hallett (NAU), Mitch Power (Univ Oregon), Dan Buckley (NPS),
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Heather Adkins, (NAU), Allison Bair (NAU), Mark Daniels (ERI-NAU),
Kirsten Ironside (NAU), Renata Jass (NAU), Taylor Joyal (NAU), Caitilin
McCracken (NAU), Rob Richardson (NAU), Jaime Toney (NAU), Alison Forrestel
(NPS), Point Reyes GIS Staff

