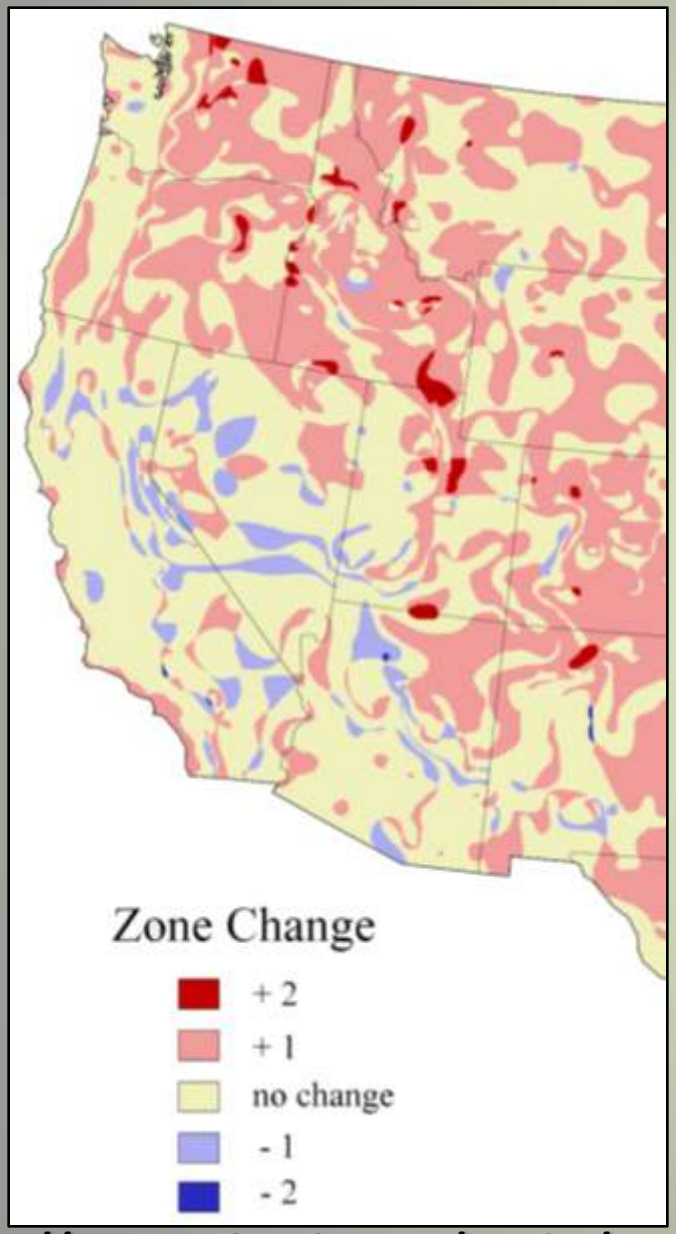
Seed-transfer guidelines in the context of climate change: a Forest Service perspective

Matt Horning

Seed-transfer guidelines in the context of climate change: a Forest Service perspective

- Skipping doom-n-gloom (nuts and bolts of climate change)
- Who is at risk (winners v losers)
- Suggested action items
- Decision support tools

“Climate” is a moving target



- Rapid change
- High uncertainty
- Not the means but the extremes
- Future environmental conditions many not exist right now?
  - Warmer winters but still late frosts
  - Photoperiod vs heat sums
  - Different disease triangle relationships

http://www.arborday.org/media/map_change.cfm

Will plants naturally adapt to rapid climate change?

Three possibilities when environments change:

1. **Move**
   - Migrate to new habitats
2. **Stay**
   - Acclimate by modifying individuals to new environment (phenotypic plasticity)
   - Evolve through natural selection
3. **Disappear**
   - Extinction of local population

Aitken et al. 2008. Evolutionary Applications 1: 95-111.

Species/Populations most threatened by climate change:

Calamagrostis breweri

- Long-lived species
- Genetic specialists
- Low dispersal potential
- Low genetic variation
  - Inbreeding species
  - Small populations
  - Fragmented, disjunct populations
- Rare/Threatened
- "Nowhere to go"

Pinus albicaulis

Tree Species of Concern

Eastern regions:

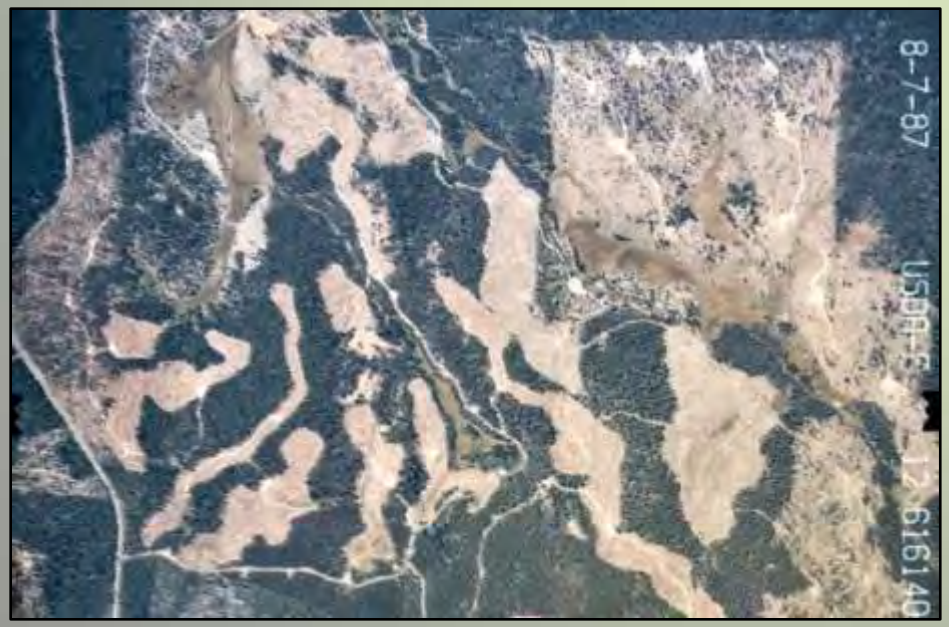
- butternut
- oak spp.
- ash
- eastern hemlock

Western regions:

- 5-needle pines: white pine, sugar pine, whitebark, bristlecone, limber, pinyon, foxtail
- Port-orford cedar
- Western red cedar
- Subalpine fir
- Mountain & western hemlock
- Englemann spruce
- Tanoak
- Monterey pine, knobcone pine
- Cupressus spp.
- Torrey pine
- Brewer spruce
- Coast redwood
- Alder spp., cottonwood, aspen, birch

Management implications for forested lands

- Variety of management objectives
  - Timber production/Ecosystem Health
- Long rotation time for harvests
  - Very difficult for planning
  - Potential implications for harvests



Forest Service Genetics Workshop in Corvallis Oregon March 2010

- National Forest System geneticists
- Some Forest Service R&D geneticists
- Others… Oregon State University, University of British Columbia, BC Ministry of Forestry, Climate Change Research Institute & Oregon Climate Service

Forest Service Geneticists

"Studying climate since 1908"

Agreement Among Participants: Four Principles

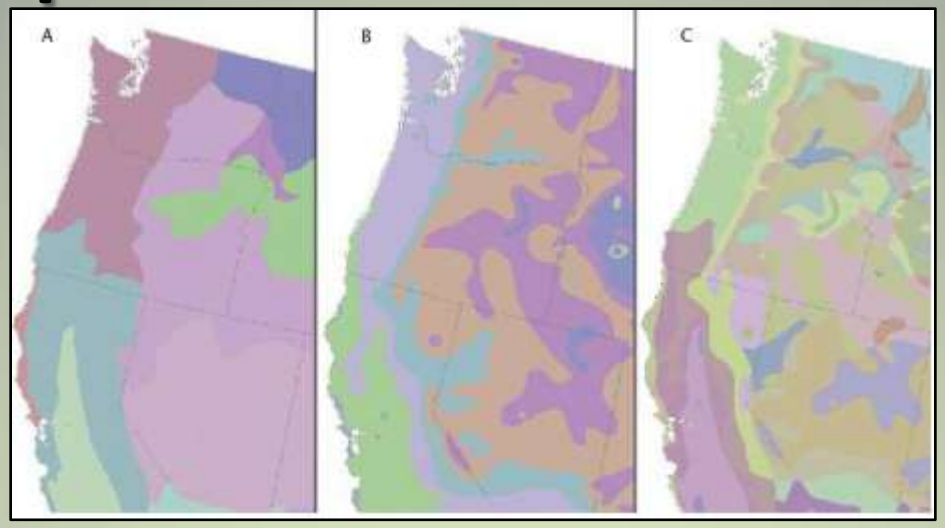
1. **Start with what has been working:**

   locally-adapted regionally-appropriate seed sources

2. **Genetic diversity is a good thing**
3. **Take large risks on small areas, and small risks on large areas**
4. **Need for genetic conservation**

Not prescriptions, but concepts

Principle 1: Stick with what works



2010 Native Plants Journal 11: 117-132

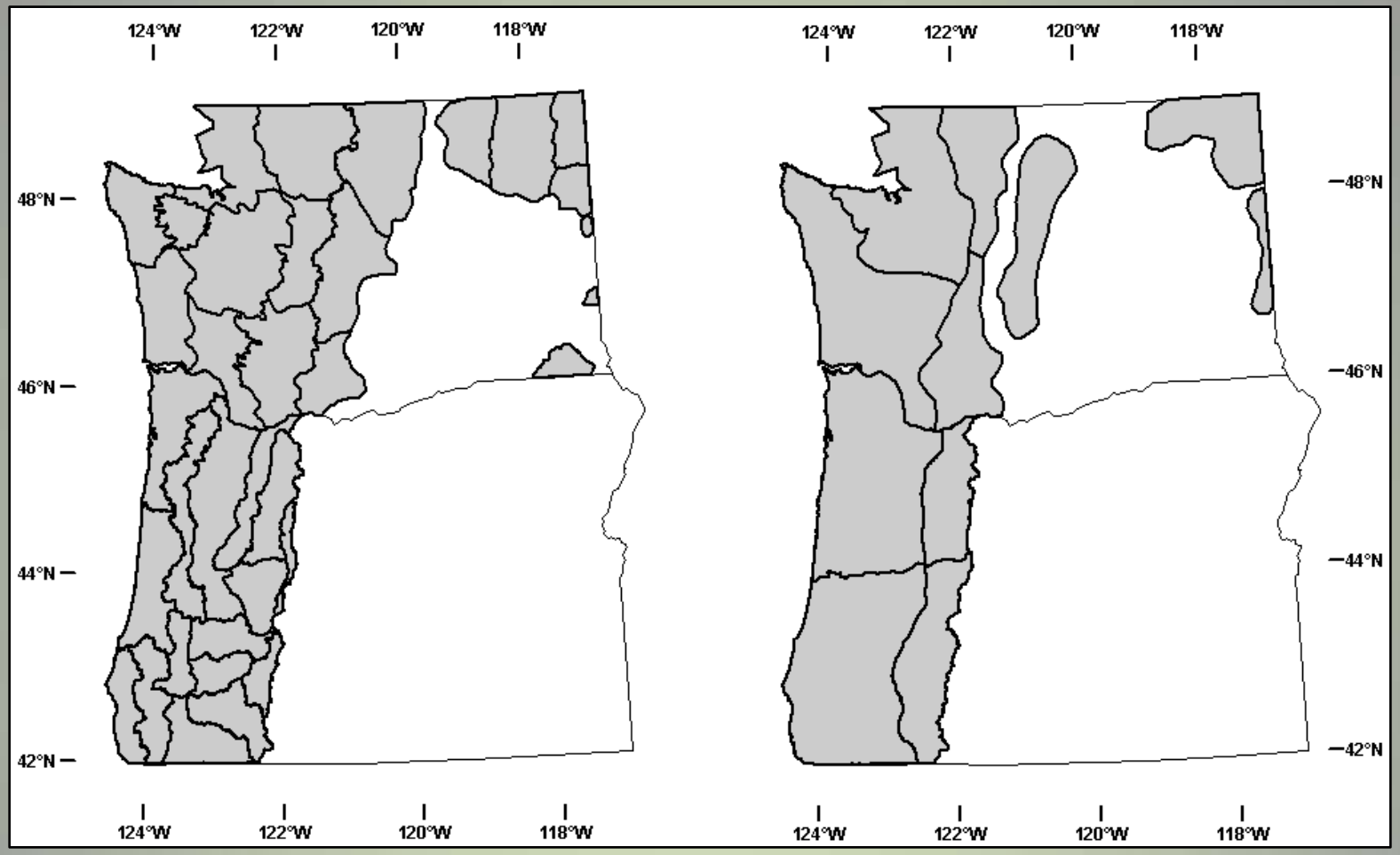
What are the best seed sources for ecosystem restoration on BLM and USFS lands?

Randy Johnson, Larry Stritch, Peggy Olwell, Scott Lambert, Matthew E Horning, and Richard Cronn

- **Native species**
- **Genetically appropriate**
- **Locally adapted**

But how 'local' is 'local'?

Differential adaptation to environment



Douglas-fir; *Specialist*
655ft, 18 FFDs

Western redcedar; *Generalist*
1968ft, 54 FFDs

- **Species differ in their level of adaptation to local environment**

Adaptation in other forest species

- Growing evidence for local adaptation
- Different species show different patterns and scales of adaptation
- Moderate degree of adaptation (generalists)

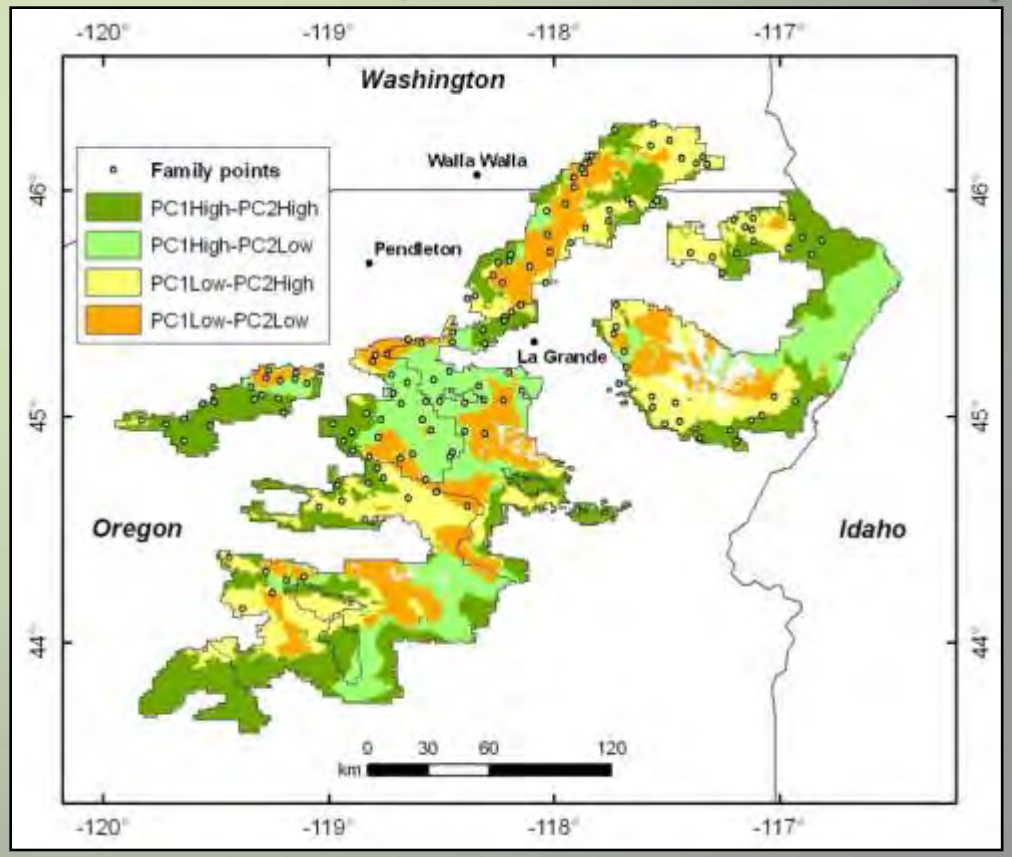
But…is 'local' still 'local'?

or

Where will the climate values that currently explain observed genetic variation move to given future predictions?"

Bromus carinatus; Johnson et al 2010 Botany

- Previous studies typically based on historical climate data (1960's – 1990)
- "Climate smart" data are now available
- Allows us to explore how seed movement guidelines might be adjusted



Principle 2: Diversity (Genetic Variation) provides insurance

Phenological variation in Prairie junegrass

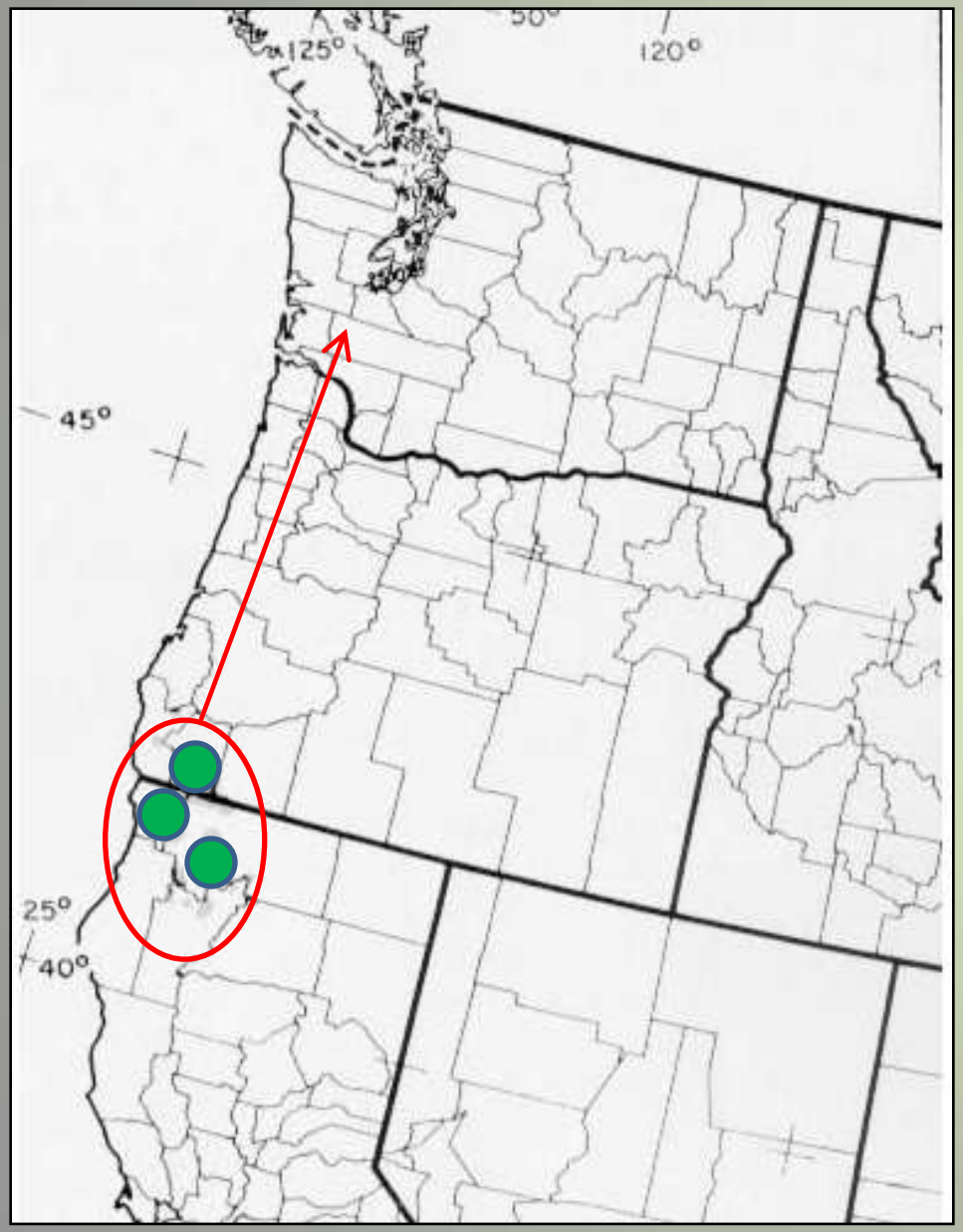
Variable frost damage in different sources of Douglas-fir seedlings

- Not just diversity for diversity's sake
- Adapted variation (ID'd via CGSs)
- Maladapted variation can reduce fitness

Principle 3: Large Risks over Small Areas Small Risks over Large Areas

- Estimates of past migration rates vary
  - Davis and Shaw 2001: 200-400 m per yr
  - Aitken et al 2007: 100- 200 m per yr
- But current rates of climate change might require 3000-5000 m per yr
  - Seed migration may not be sufficient
  - Pollen flow may be ineffective due to non-synchronous flowering phenology

Example: Small risks over large areas



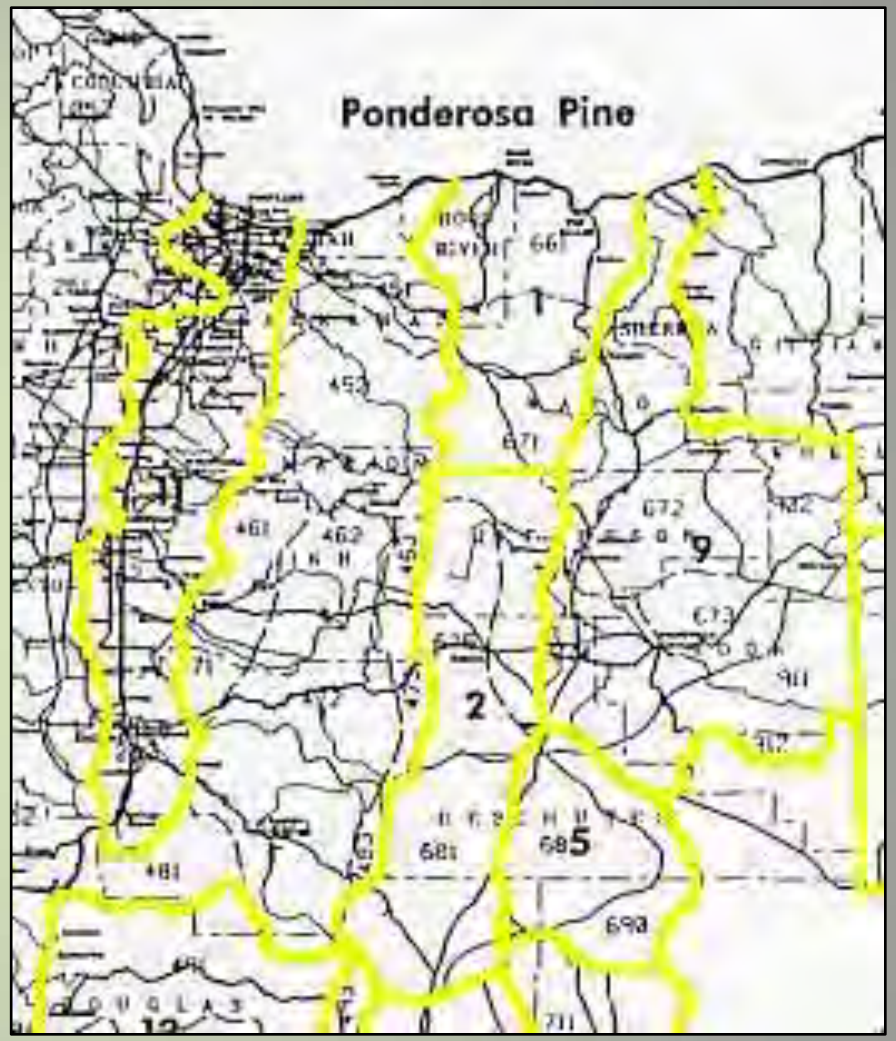
Brewer spruce

- **Broad spatial emphasis**
- **Small amount of materials**
- **Experimental context**

Example: Large risks over small areas

Perhaps…
•Move materials between adjacent zones

Better yet…
•Widen/adjust elevation bands within zones



- ↑ Diversity (bet –hedging)
- Small spatial scale
- Large quantities of materials (Mixing, not replacing)
- Operational/Experimental context

Decision Tools and Resources

Seedlot Selection Tool (SST)

http://sst.forestry.oregonstate.edu/PNW/index.html

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http://sst.forestry.oregonstate.edu/PNW/index.html

User inputs and actions

Choose analysis approach…….. → ***Find seedlot or planting site; Use zone or seed transfer rule***

Select species and climate variables… → ***Choose from a list of species; Uni- or multivariate climate variables***

Select location…… → ***Location of seedlot or planting site***

Select future climate model (GCM)…… → ***GCM1, GCM2, GCM3***

Select year of interest…… → ***Present, 2030, 2060, 2090***

Optional return to parameters and scenarios

Climate space of the selected zone or transfer rule in the chosen year

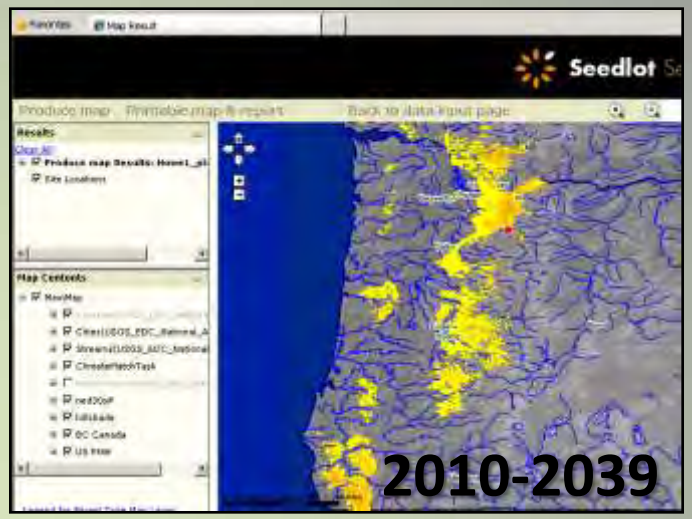
Review output map, change parameters if desired, download map…… ← ***Map***

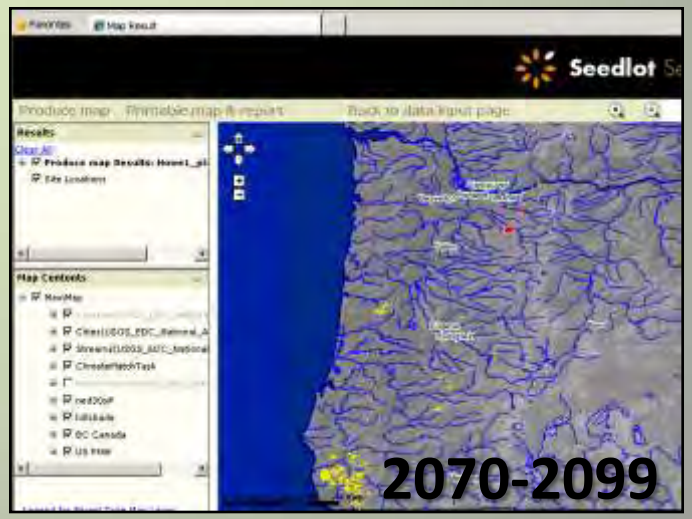
Web browser

Web server tool

Ron Beloin, Glenn Howe, Brad St.Clair, Lauren Magalska, USFS Climate Change Research Program

Output used for planning and education





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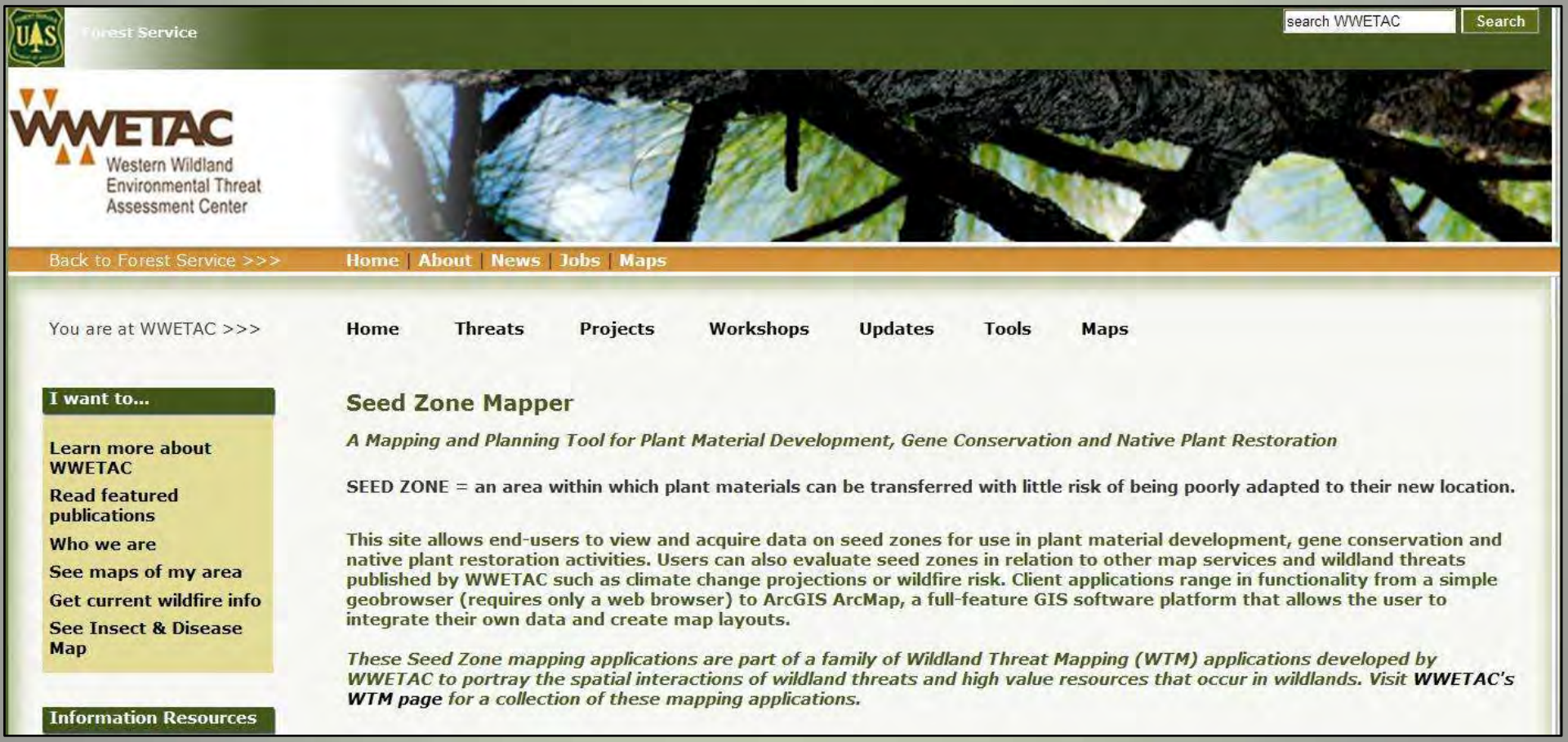
Seed Zone Mapper

V Erickson, A Bower, C Schrader-Patton, A Ager



http://www.fs.fed.us/wwetac/threat_map/SeedZones_Intro.html

Spatial data available for download

Download Edited Provisional Seed Zone GIS data:

Dataset	Extent	Download	Map	More Info
Edited Provisional Seed Zones	Northern Great Basin	SHP Shapefile	PDF	PDF
Edited Provisional Seed Zones	Central Great Basin	SHP Shapefile	PDF	PDF

Download Empirical (Common Garden Studies) Seed Zone GIS data:

Dataset	Extent	Download	Map	More Info
Blue wildrye (*Elymus glaucus*)	Blue Mountains Ecoregion (Oregon, WA)	SHP Shapefile	PDF	PDF
Mountain Brome (*Bromus carinatus*)	Blue Mountains Ecoregion (Oregon, WA)	SHP Shapefile	PDF	PDF
Prairie junegrass (*Koelaria macrantha*)	Columbia Basin and Great Basin	SHP Shapefile	PDF	PDF

http://www.fs.fed.us/wwetac/threat_map/SeedZones_Intro.html

Choose your interface

WTM Seed Zone GeoBrowser

The SeedZone GeoBrowser is an interactive 2D map that displays in your internet web browser - no software installation is required. To navigate around the map, Left-click and drag your mouse to pan, use your mouse wheel or the slider control in the upper left to zoom, and Shift-Left click to drag to define a new map extent.

WTM Seed Zone GeoBrowser - Google Earth

Like the SeedZone GeoBrowser, the Google Earth application functions inside your web browser, except it is in 3D and uses the Google Earth globe. A small software plug-in is required; you will be prompted for this the first time the application attempts to load. (Note: USFS users will need administrative privileges to load the plug-in).

WTM Seed Zone KML file (Google Earth)

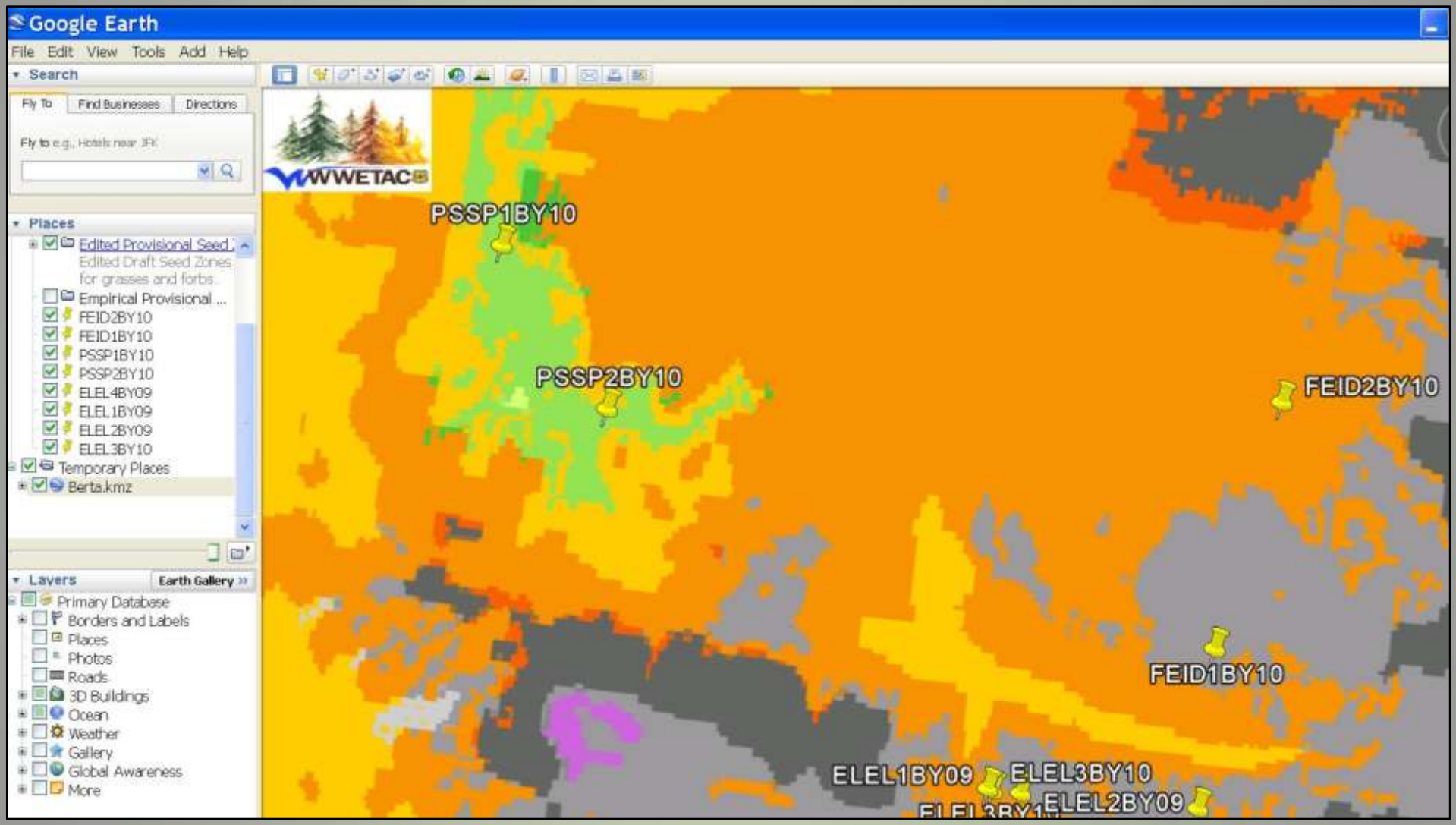
If you have desktop **Google Earth** installed, you can view seed zone layers by loading a KML file. The KML file may load and initialize Google Earth when the link is clicked, or you may have to Right- click and use 'Save As' to download the file to your PC then open the file in Google Earth.

WTM Seed Zone MXD file (ArcMap)

ArcMap is GIS software from **ESRI**; if you have ArcMap installed on your PC, this map document (.mxd) contains links to the served WTM and Seed Zone layers and can be opened in ArcMap. Using ArcMap you can load and view your own local or enterprise GIS data with the SeedZone layers. To download the seedzone.mxd file, Right-click on the above hot-link title text and select 'Save As'.

http://www.fs.fed.us/wwetac/threat_map/SeedZones_Intro.html

Example: VGE interface



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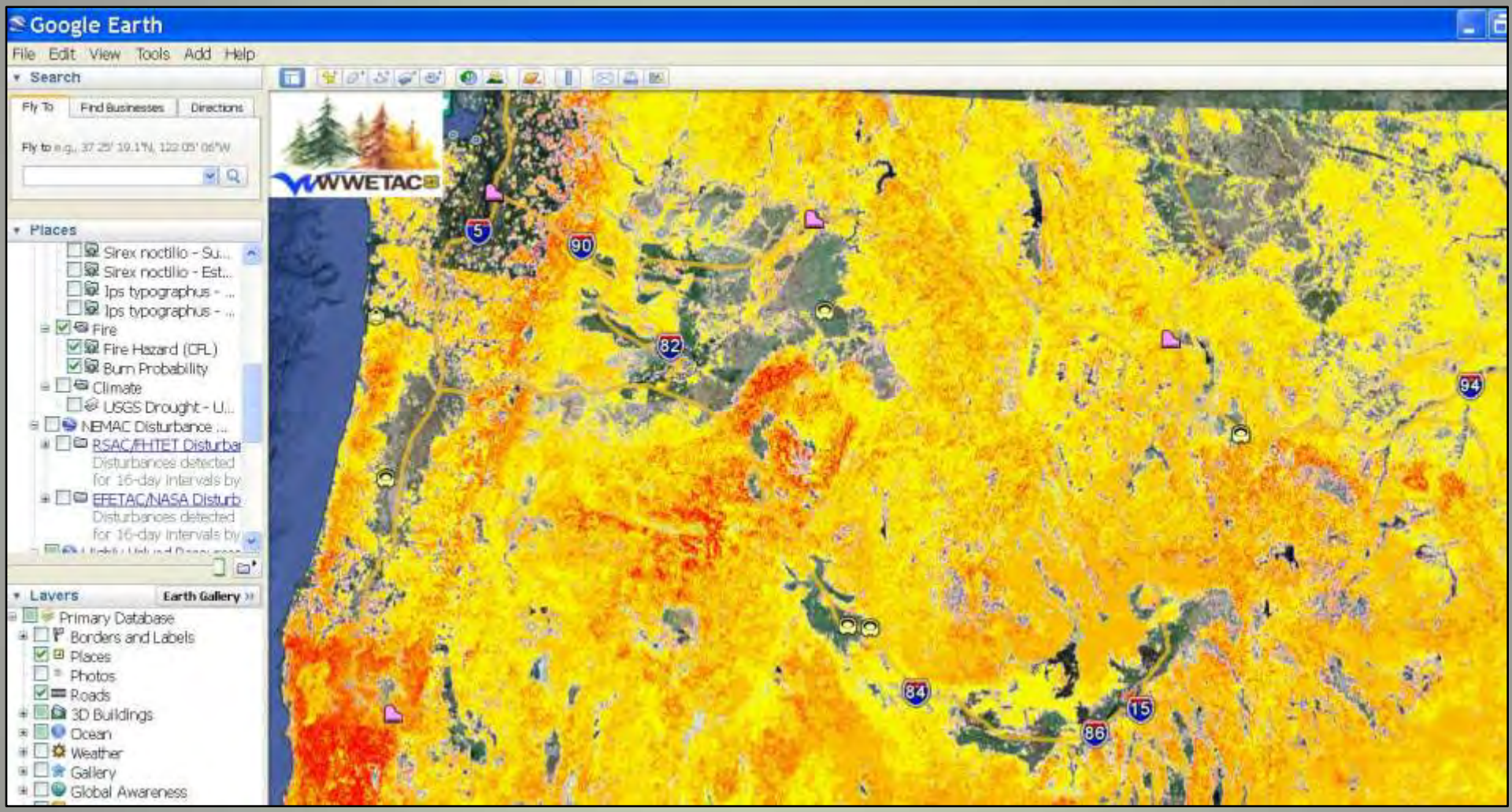
Value-added products: Fire Risk



http://www.fs.fed.us/wwetac/threat_map/index.html

Caveats

- Any type of seed zone etc is only a *starting point*
- Decision support tools are just that
- Local knowledge is essential for assessing rec's

Additional complicating factors Influencing Species Presence:

- Soils
- Competition
- Disease and insects
- Fragmentation

Questions?

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