

Climate diversity and protected areas

- Climate diversity of Bay Area reserves
- The velocity of climate change
- Conservation implications

David Ackerly, UC Berkeley
State of the Laguna Conference,
October 14, 2009

California Bay
Umbellularia californica

Future Range

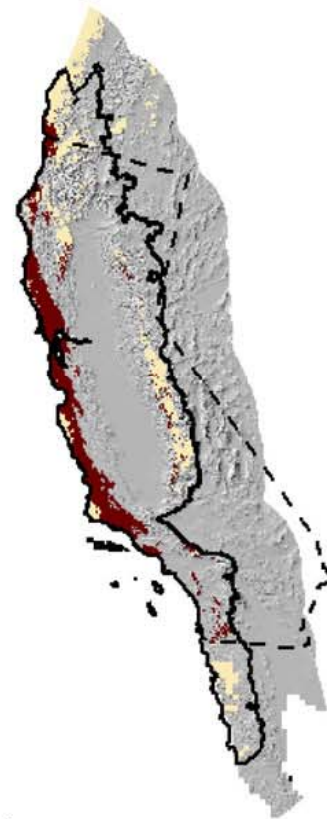
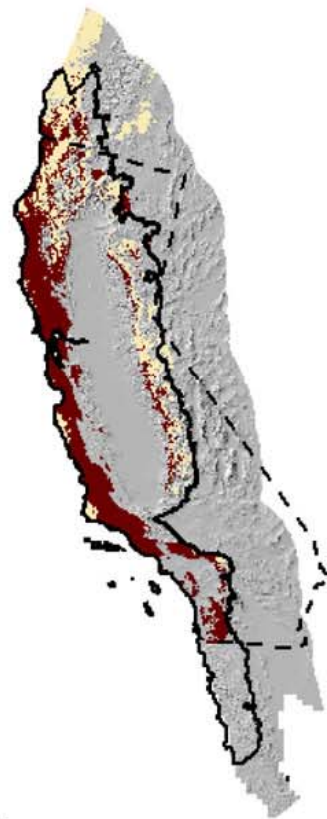
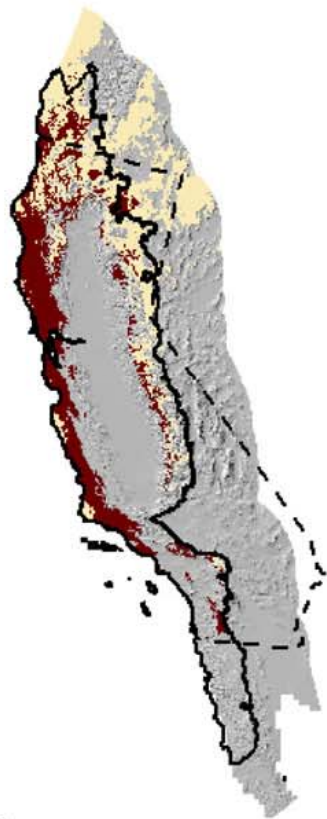
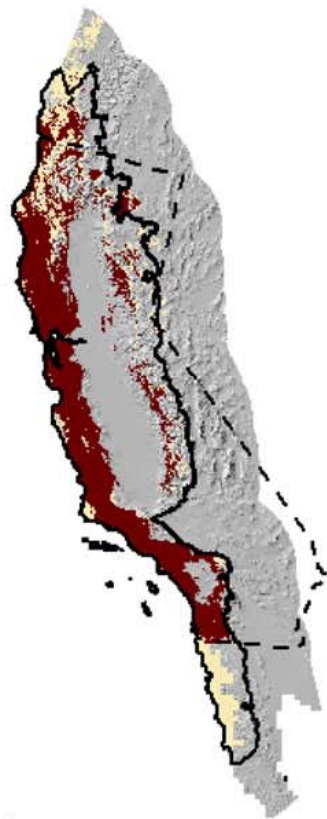
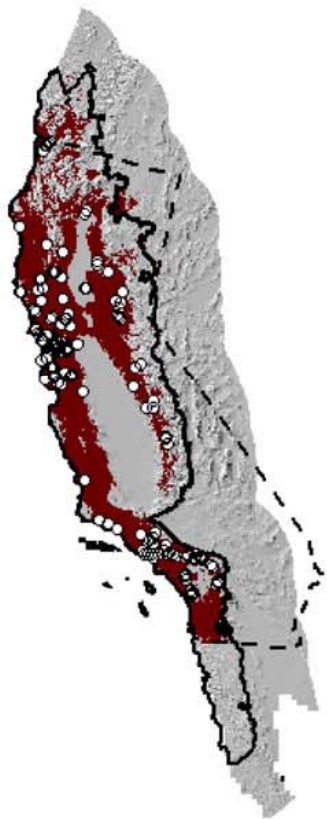
Current Range

Less sensitive simulation
Lower emissions

Less sensitive simulation
Higher emissions

More sensitive simulation
Lower emissions

More sensitive simulation
Higher emissions



■ Current range ○ Herbarium specimens

■ Future range

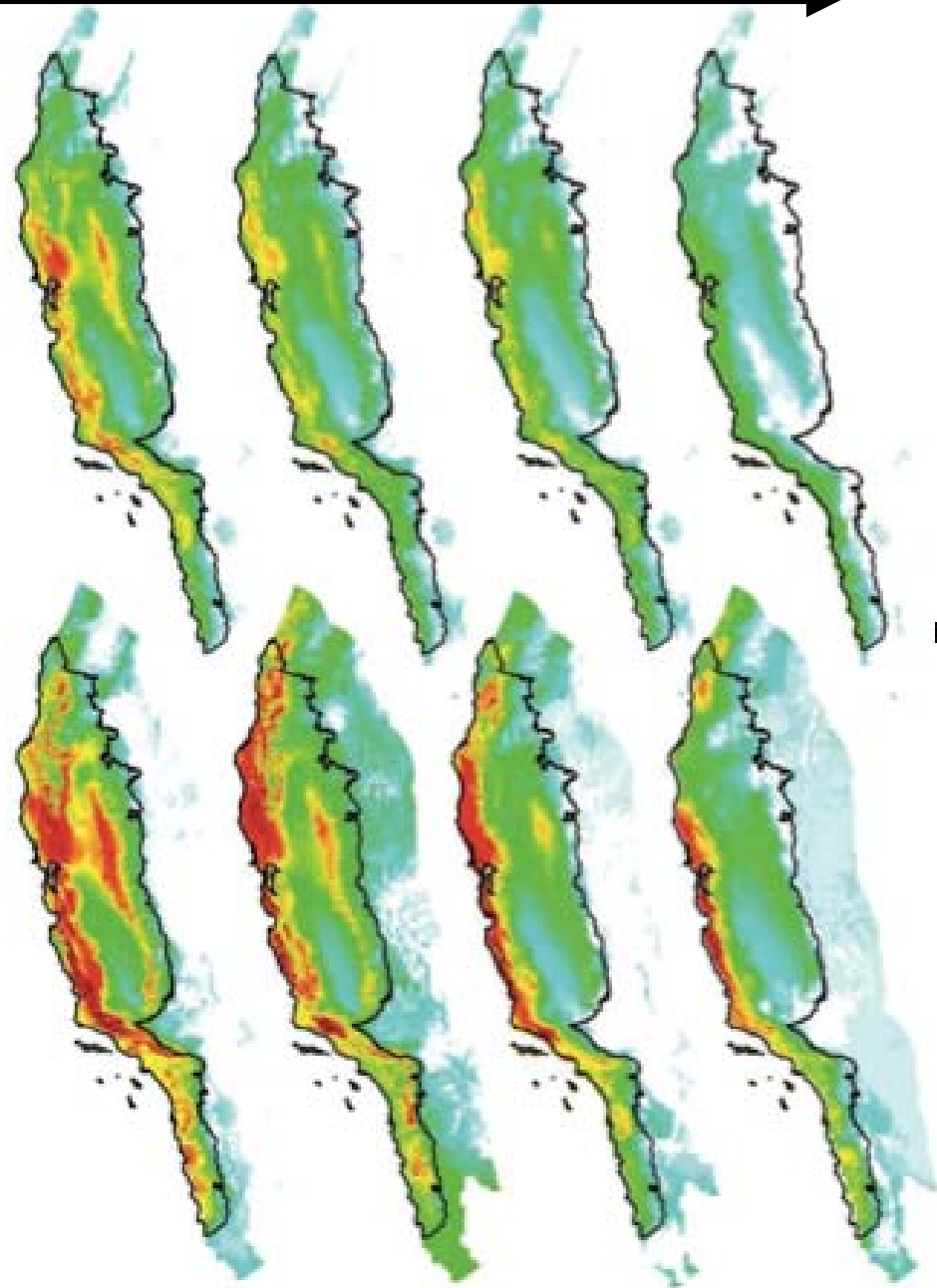
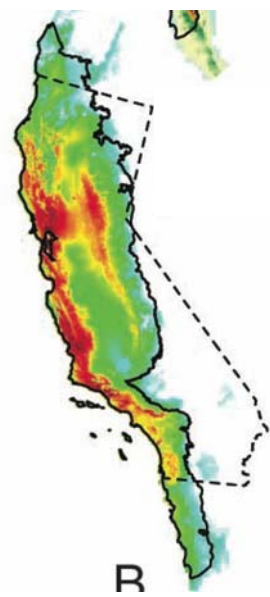
■ Future range (pending dispersal)



increasing severity of climate change

*Future
diversity*

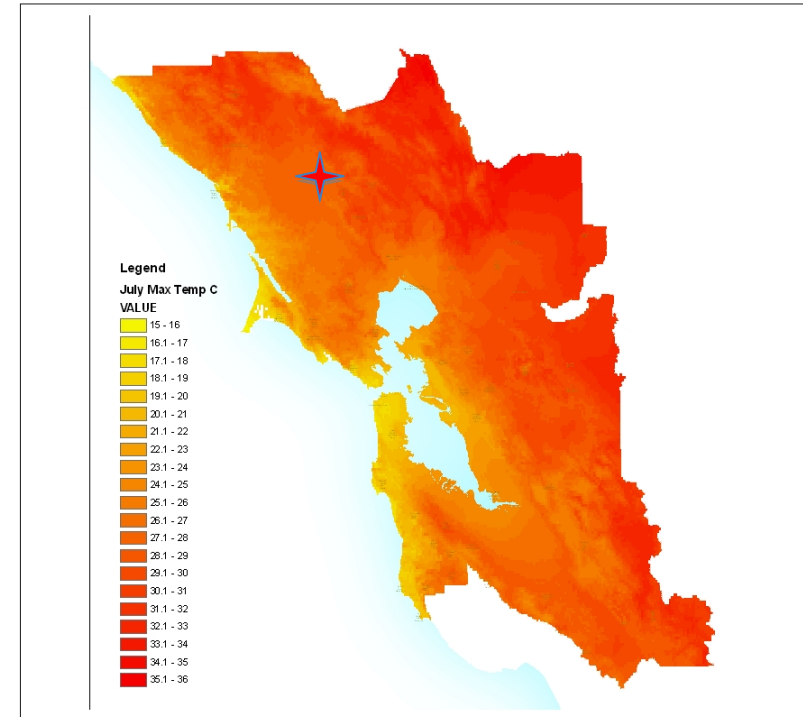
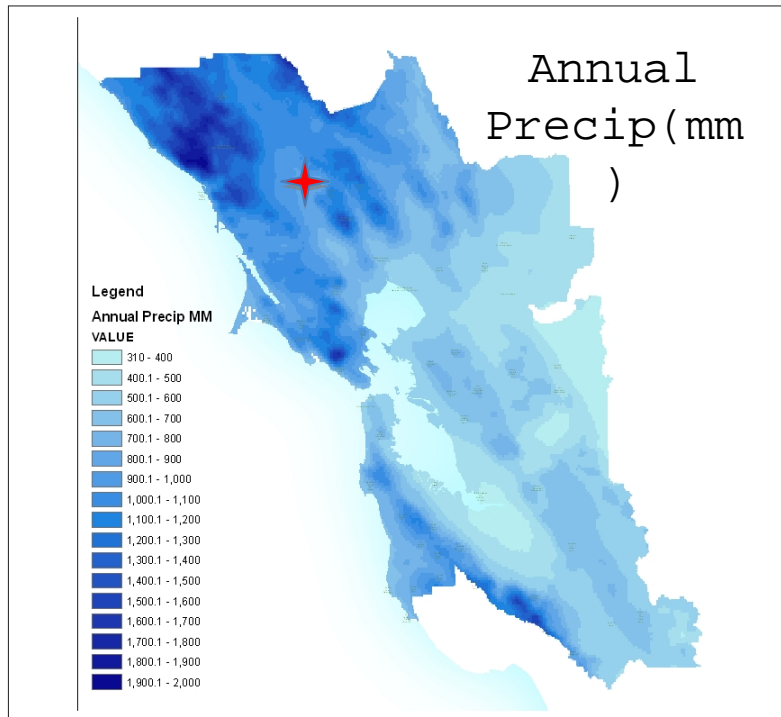
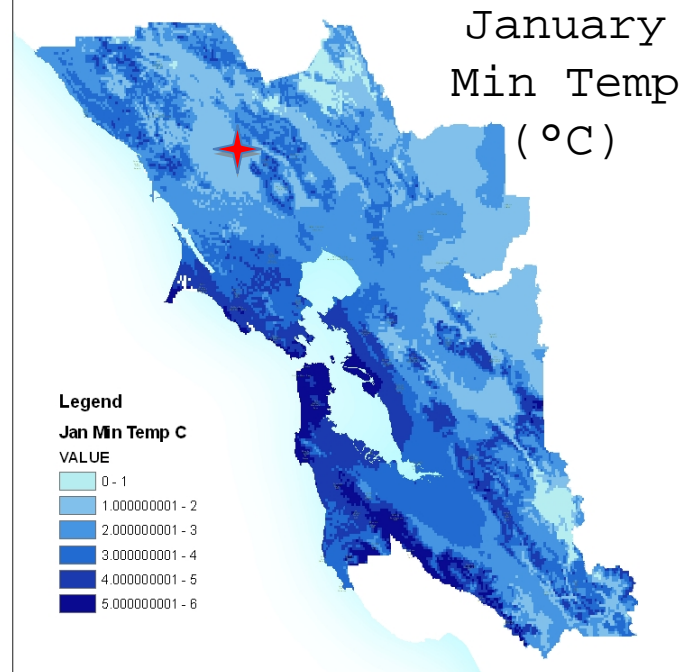
Y



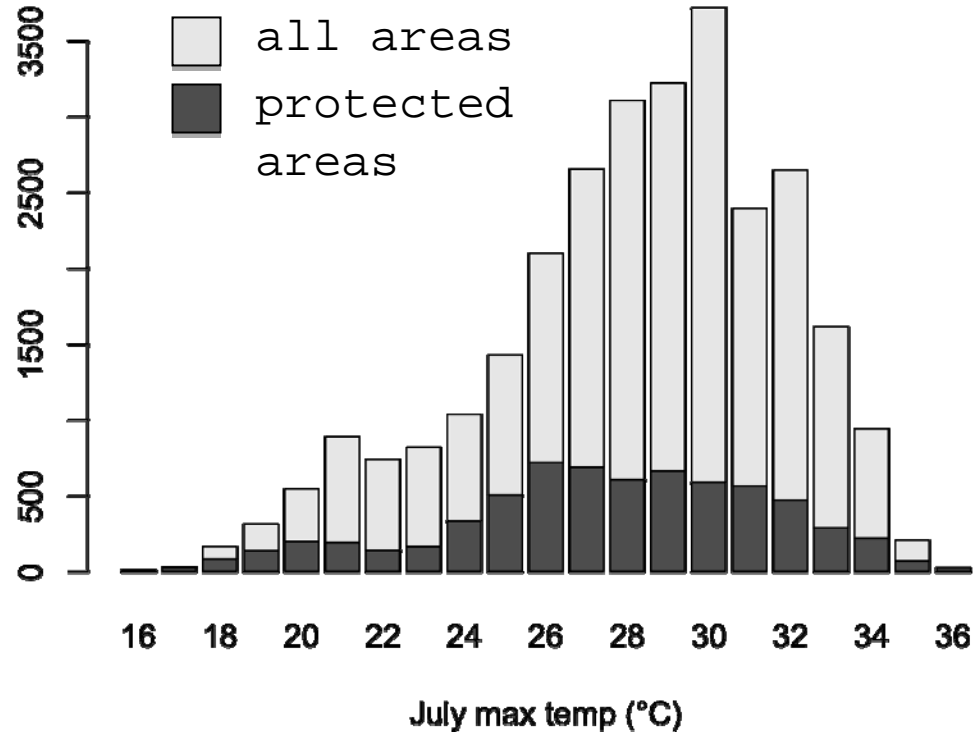
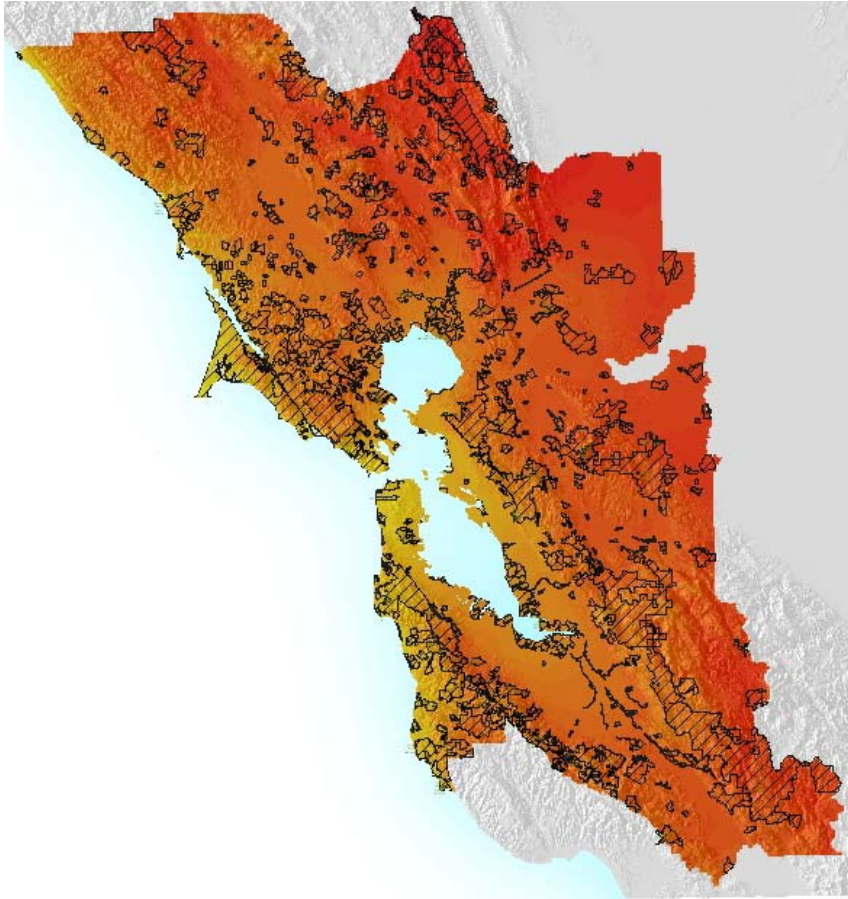
no
dispersal

□
unlimited
dispersal

Bay Area Climate (PRISM)



Histogram of July max temps



Climate diversity and design of reserve networks

Other things being equal....

1) reserves with greater climate diversity
are expected to:

support greater diversity of habitats
likely support greater species and
genetic diversity

provide places to go as climate changes
but: could mean smaller areas of each
habitat

2) acquisitions that expand and connect
reserves along steep climate gradients
should enhance all of these advantages

Climate diversity

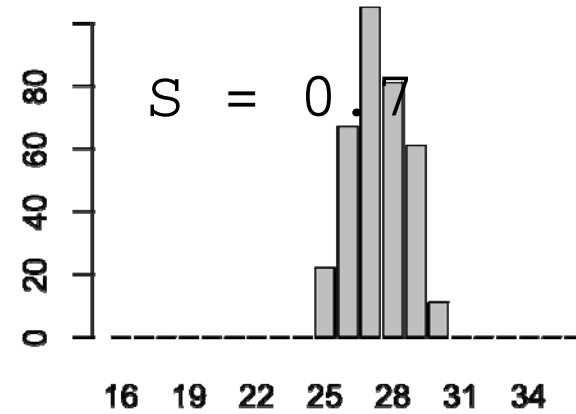
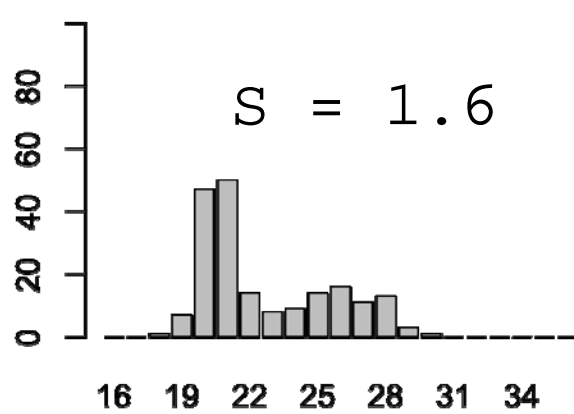
Ecological measures of diversity increase when:

- the *number* of entities increases (e.g., species)
- the *evenness* of relative abundances increases
- (in some cases) the *distinctness* of the entities increases

Rao's quadratic index

$$S = \sum \sum d_{ij} p_i p_j$$

Climate diversity example

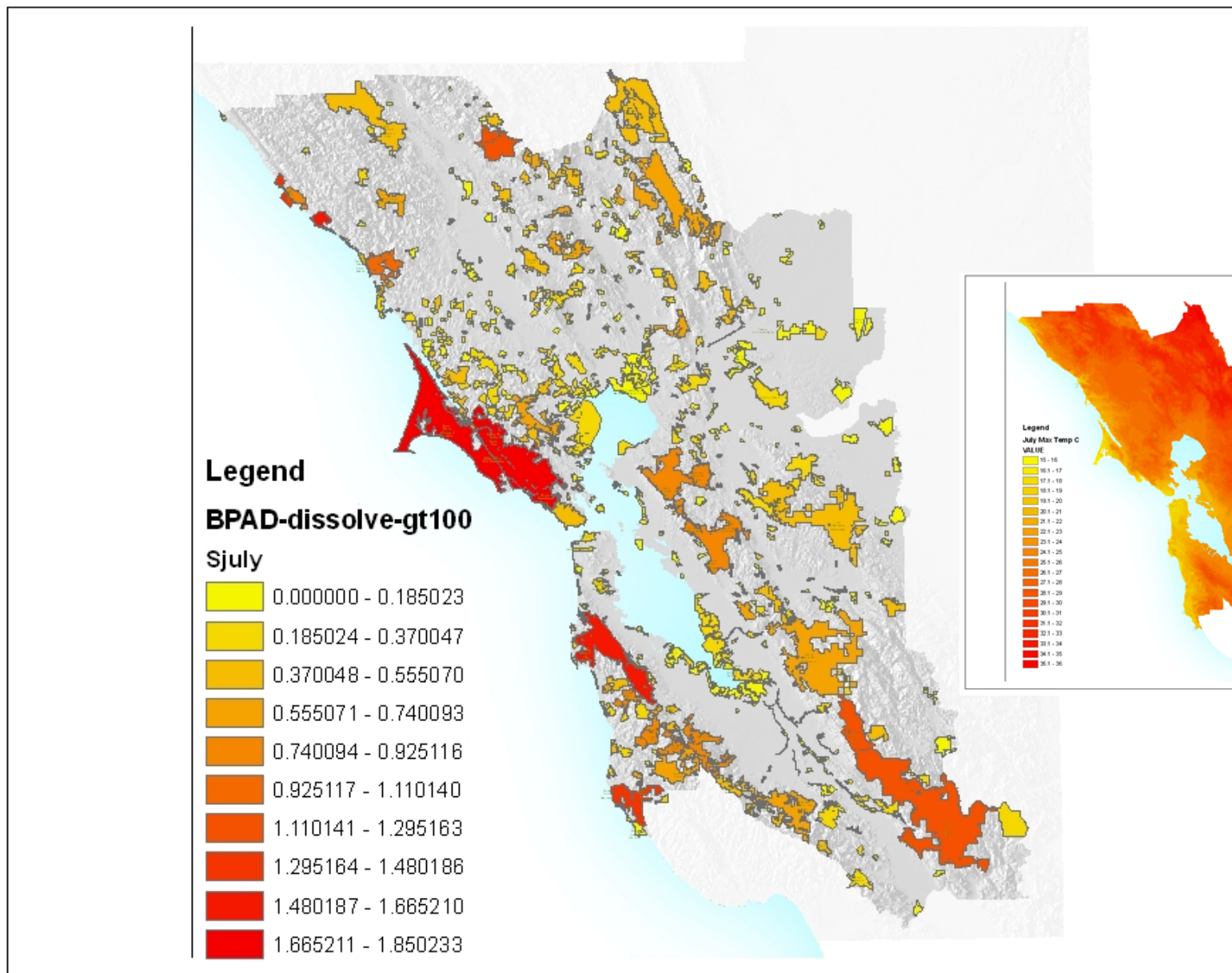


July temp

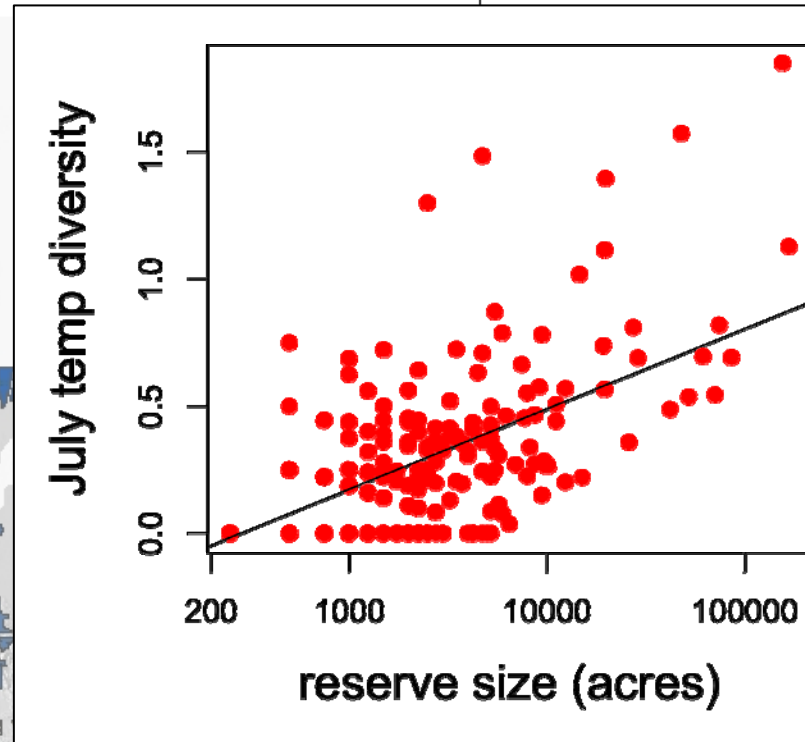
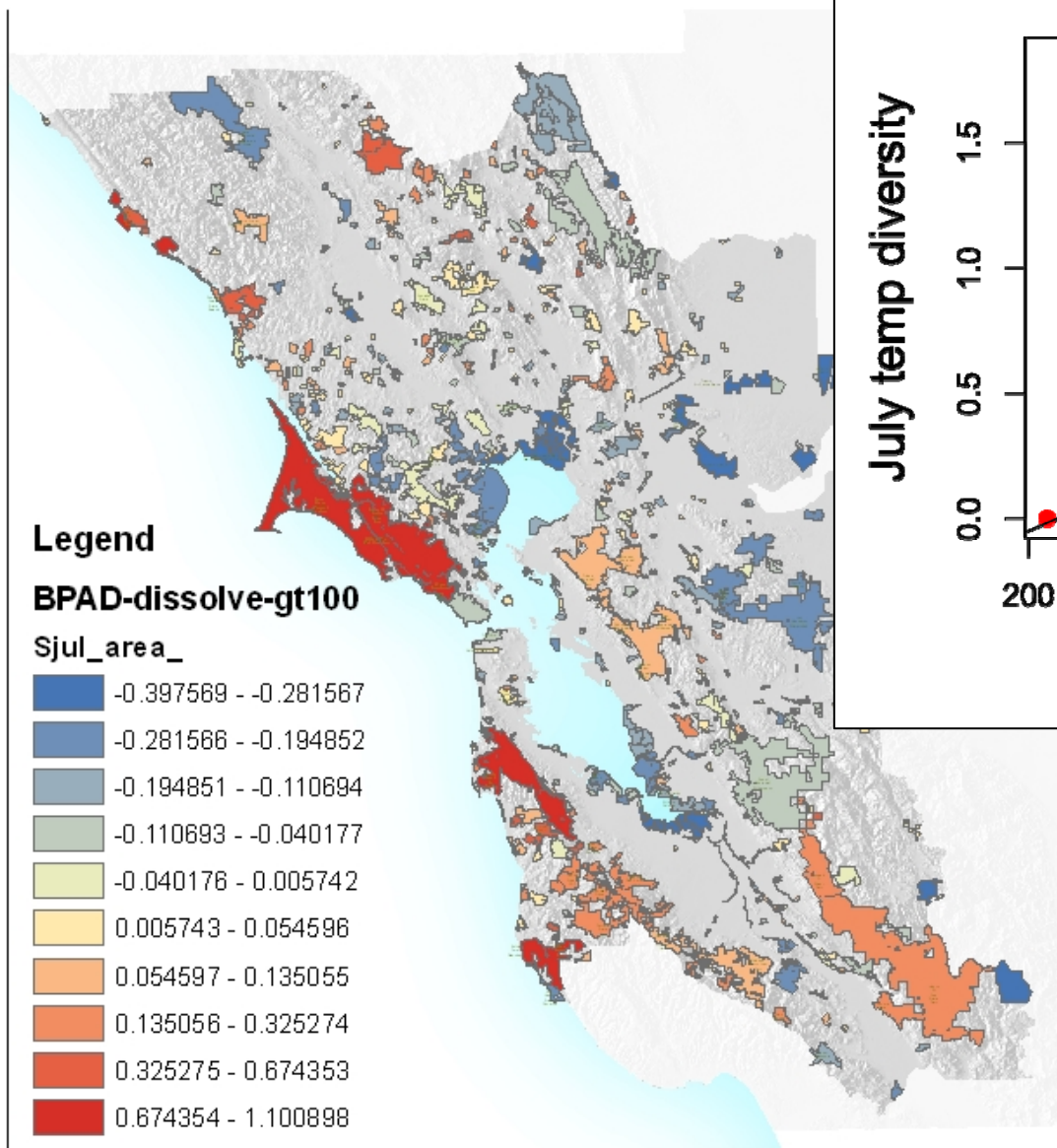
July temp



Diversity of July max temp by reserve (NOT normalized by reserve size)



Diversity of July max temp by reserve (normalized by reserve size)

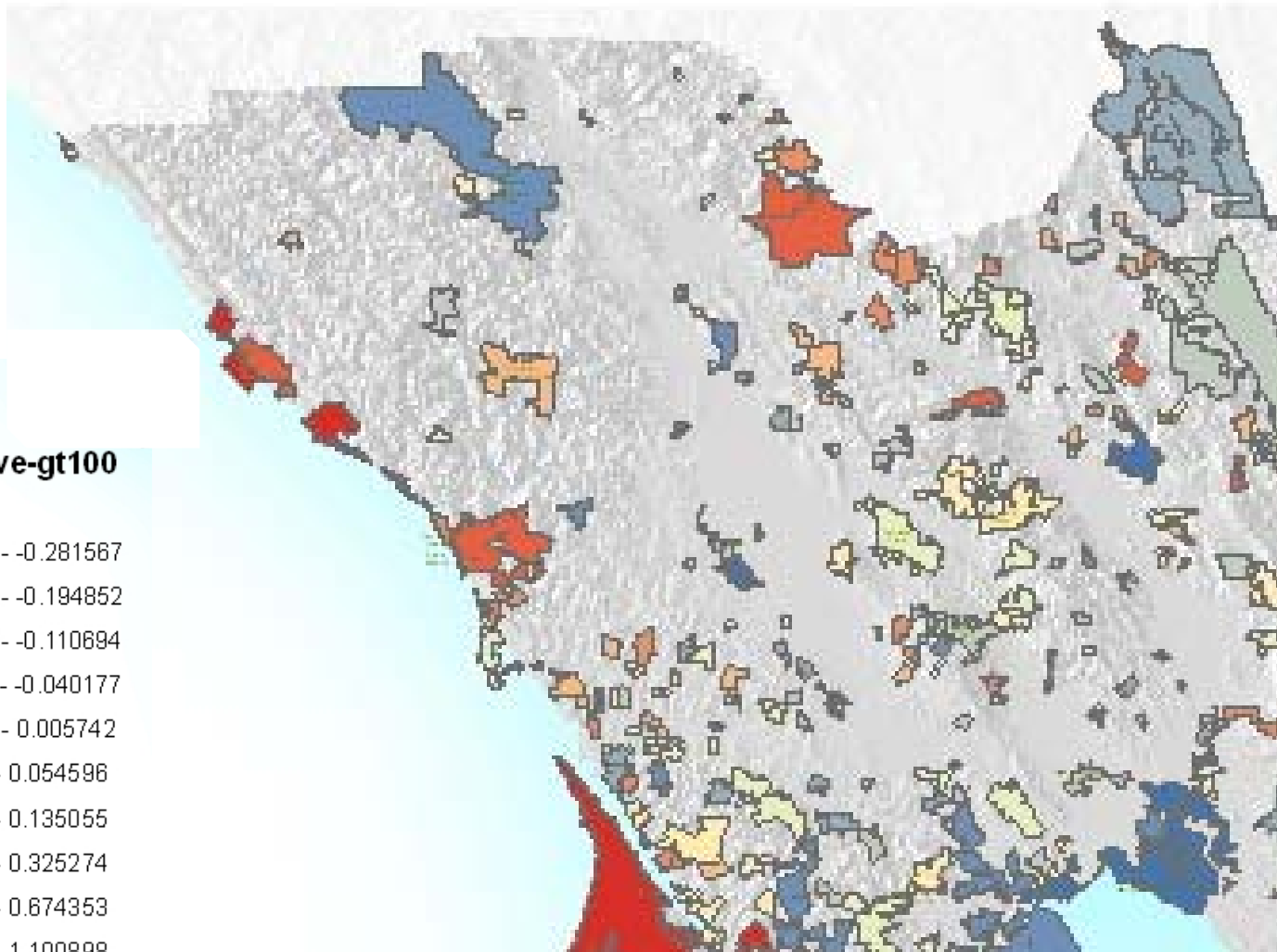
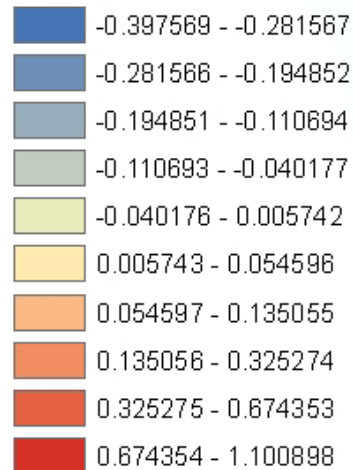


Diversity of July max temp by reserve (normalized by reserve size)

Legend

BPAD-dissolve-gt100

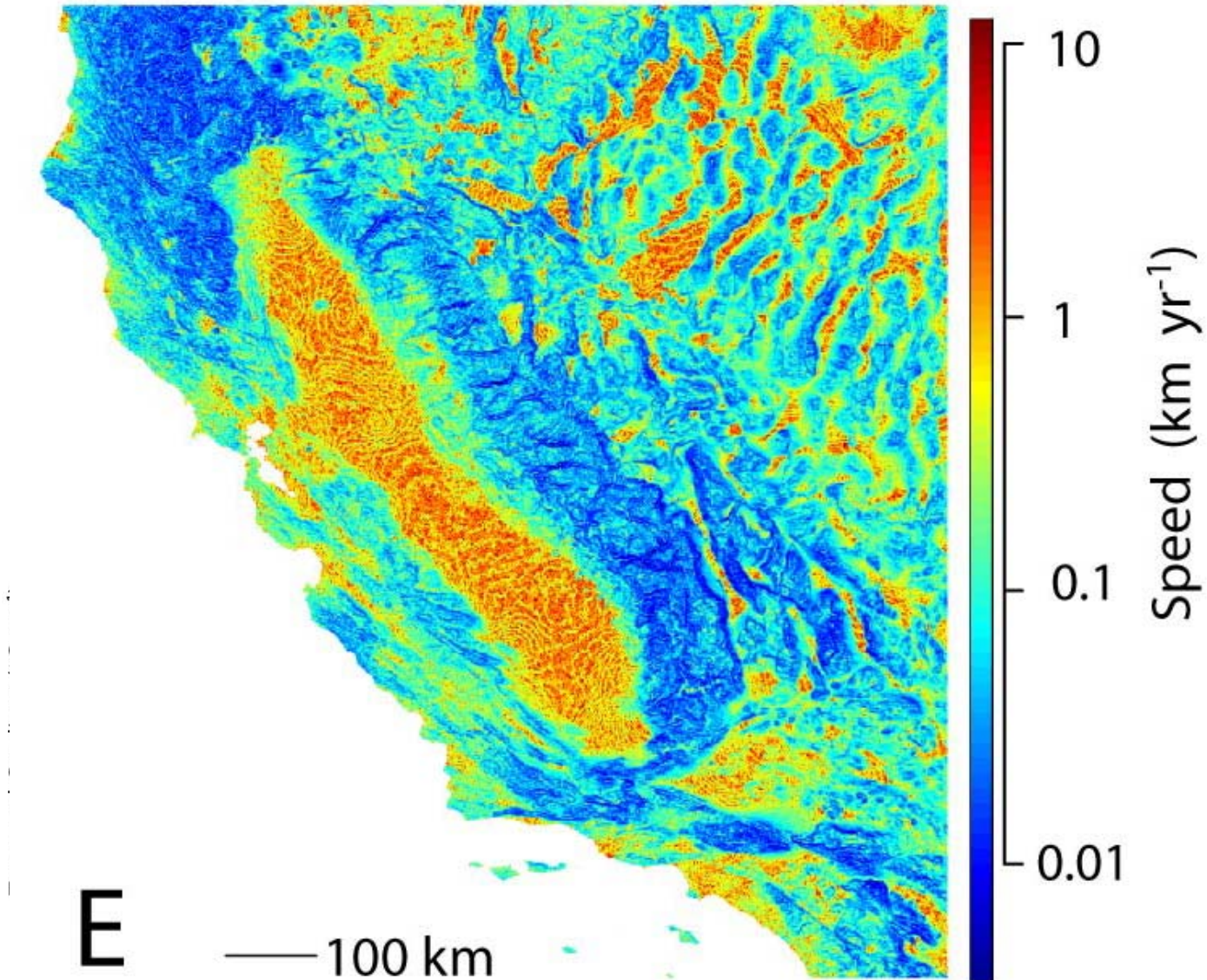
Sjul_area_



Next steps

- Evaluate climate diversity vs. species/vegetation diversity
Bay Area as a test case
- Incorporate climate diversity and other metrics in Upland Habitat Goals conservation planning analysis
- Focus on portfolio value of reserve network in addition to value of individual reserves

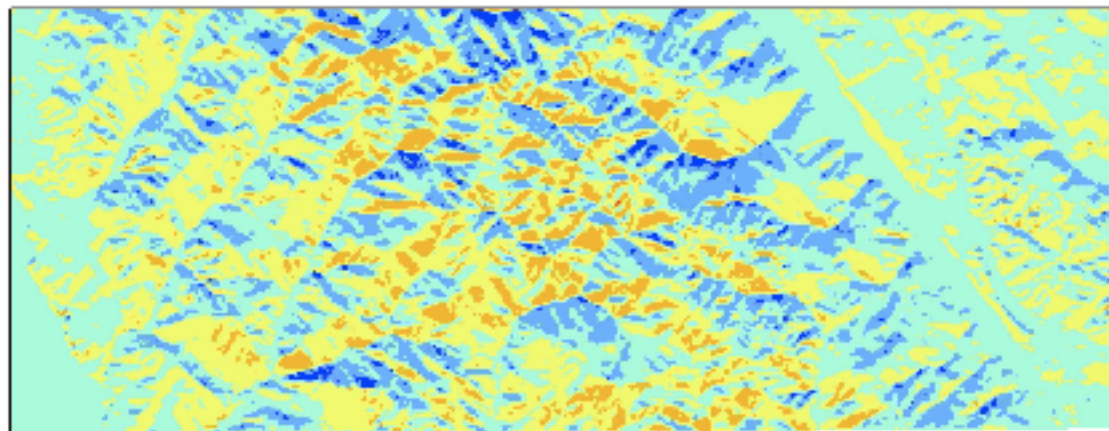
Climate velocity: $^{\circ}\text{C}/\text{yr} \div$
 $0.01/\text{km} = 1\text{km}/\text{yr}$



Topoclimate adds diversity at smaller spatial scales

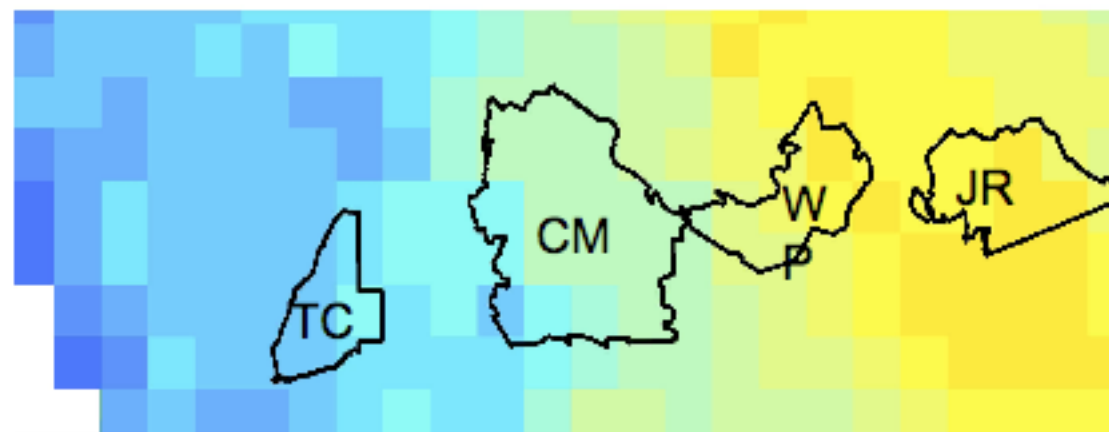
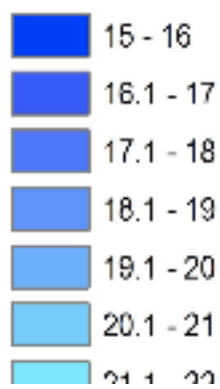
Temp Differential 0.2 degC per MJ/M2

Tmax_Jul_Diff



PRISM July Tmax

Jul_Tmax_Rad



Courtesy Stu Weiss et al.

Species vs. reserve-based approaches

- *Species* and habitat-based approaches
 - Where will species move in future?
 - What is the fate of individual species or community types in a changing climate?
 - What actions will enhance conservation of individual species?
- Reserve-based approaches focus on *place*
 - What will a reserve look like in 50 years?
100 years?
 - What species will live there?
 - What actions will promote healthy vegetation, recreation value, ecosystem services, etc., even if they are not the same as those we have today?