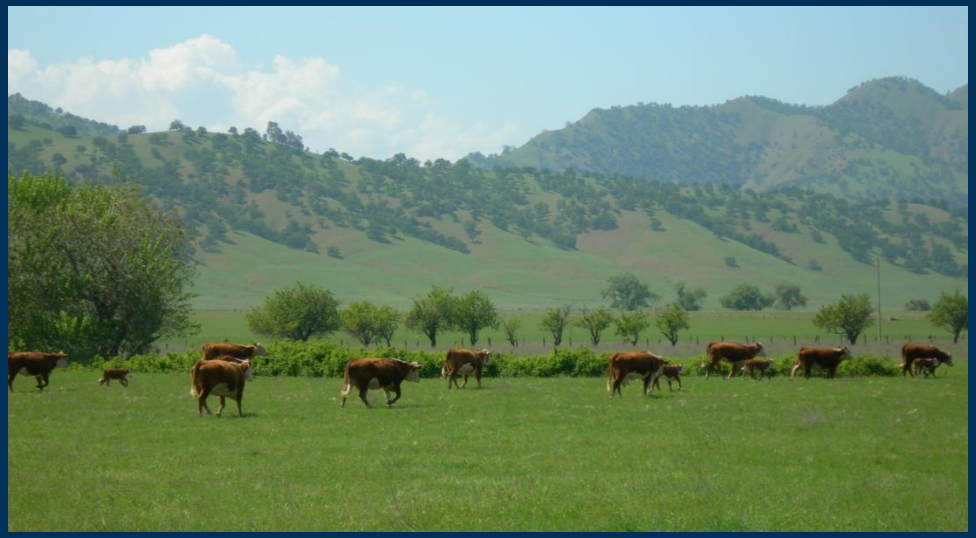
Climate change/land use change scenarios for assessing threats to ecosystem services on California rangelands

Kristin Byrd[1], Lorraine Flint[2], Frank Casey[3], and Pelayo Alvarez[4]



March 18, 2013

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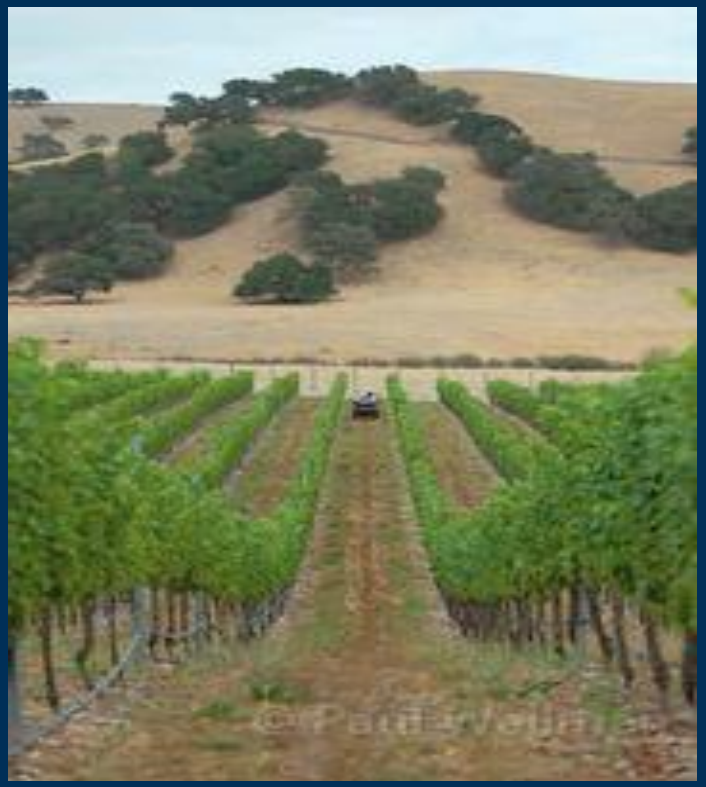
Ecosystem services provided by rangelands

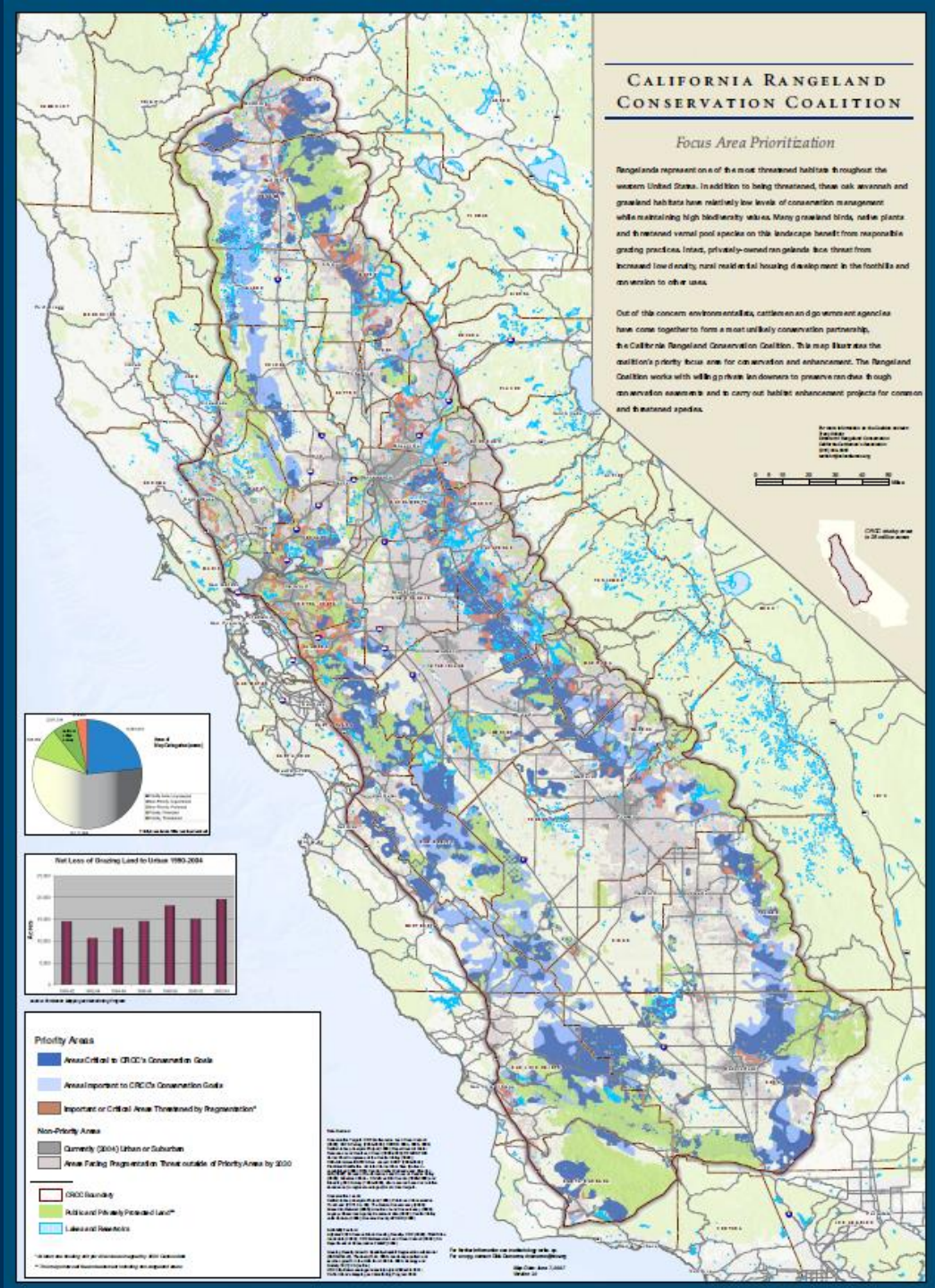
- Food, fiber and fuel
- Wildlife habitat
- Water
- Carbon sequestration
- Adaptation to climate change
- Open space, cultural values

Integrated Threats to Rangelands

- In California 20,000 acres of rangelands are lost every year
- Privately owned
- Cattle ranching: low profits
- Low levels of protection



Land conversion and climate change lead to loss of grazing land, water availability, and altered species distribution



Rangeland Coalition Focus Area Map (TNC, 2007)

http://www.carangeland.org/focusarea.html

Dark blue: Critical Conservation Areas

(Privately-owned rangelands
that have high biodiversity value and require conservation action in the next 2-10 years.)

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Project Goals

- Six spatially-explicit climate change/land use change scenarios from years 2000 – 2100 consistent with three IPCC emission scenarios and two global climate models –

B1 (sustainability)	A1B (wealth and technology)	A2 (population pressures)
1. PCM (warm, wet future)	1. CSIRO Mark 3.5 GCM (warm, wet future)	1. PCM (warm, wet future)
2. GFDL CM 2.1 (hot, dry future)	2. MIROC 3.2 (medres) (hot, dry future)	2. GFDL CM 2.1 (hot, dry future)

- Assess potential threats to rangeland ecosystem services
  1. wildlife habitat
  2. water availability (Lorraine Flint and Alan Flint, USGS)
  3. carbon sequestration

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Project Goals, continued

3. An economic analysis of scenarios to quantify economic costs and benefits (Frank Casey, USGS)
4. A web-based visualization tool, and
5. An outreach program that will target the Rangeland Coalition network to communicate how results can be applied to conservation and land management decisions. (Pelayo Alvarez, Defenders of Wildlife)

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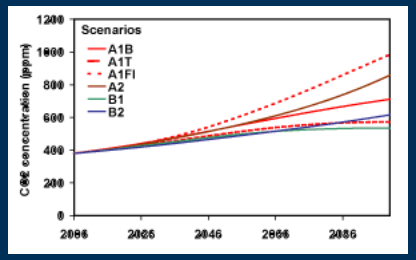


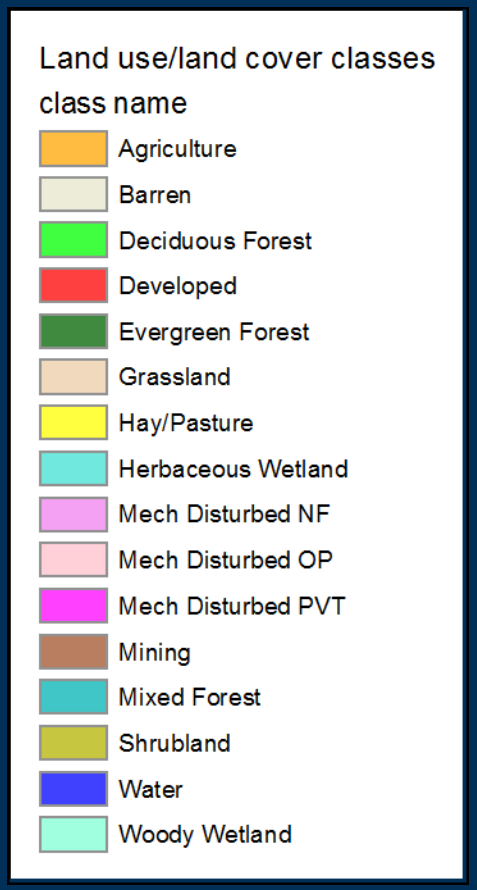
Why IPCC emission scenarios?

- Climate scenarios and land use scenarios need to be logically consistent to form the basis for integrated assessments and long-term policies (Bierwagen et al. 2010).
- Existing land-use land-cover (LULC) change modeling and downscaled global climate models based on the same scenarios – **A1B, A2, B1**
  - USGS LULC change scenarios
  - USGS ensemble projections of climate and hydrology for California (Lorraine Flint and Alan Flint, USGS)

National Assessment of Ecosystem Carbon Sequestration and Greenhouse Gas Fluxes

http://www.usgs.gov/climate_landuse/land_carbon/

USGS National Land Cover Dataset (NLCD)



- Three LULC change scenarios for each EPA Level III ecoregion (Ben Sleeter, USGS)
- FORE-SCE model: maps of LULC change by scenario/year (Terry Sohl et al., USGS)
- GEMS biogeochemical model: annual total ecosystem carbon change per LULC class (S. Liu et al., USGS)

Scenario Narratives for CA Rangelands

Rancher's Focus Group, January 2012, Davis CA

<u>Key Concerns about ranching future:</u>

- Limited availability of grazing land for lease
- Fragmentation of grazing land
- Forage quality and quantity
- High start-up investment

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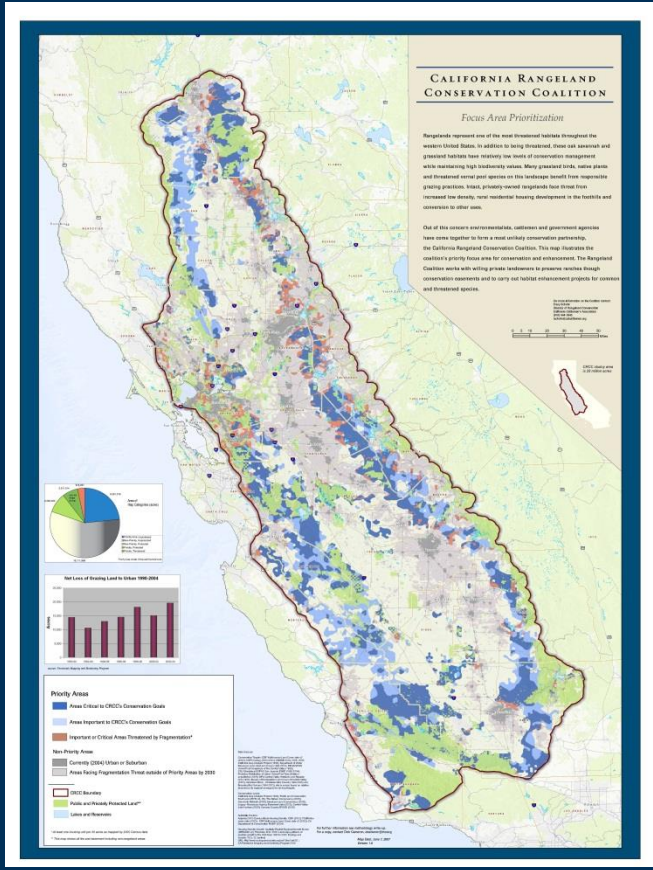
Scenario Narratives for CA Rangelands

– Alternative conservation plans

A1B (wealth and technology)	Development – low density Agriculture – high value perennial crops	Conservation – mixed-use emphasis	500,000 acres protected by 2100, near urban centers
A2 (population pressures)	Development – low density Agriculture – intensive, less innovation	Conservation – low priority	No active conservation planning
B1 (sustainability)	Development – high density Agriculture – moderate	Conservation – biodiversity high priority	1,000,000 acres protected by 2100, in high biodiversity areas

Integrated Scenarios



California Rangeland Conservation Coalition Focus Area

Three IPCC scenarios (A1B, A2, B1)
Two climate models (warm, wet or hot, dry)

↓

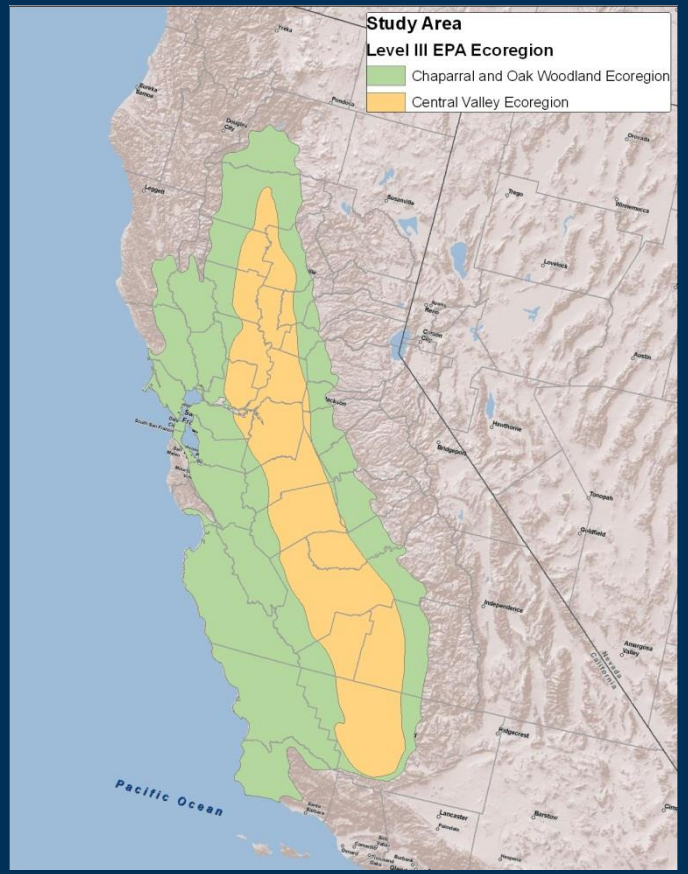
Land use/land cover change +

↓

Climate/hydrology decadal change

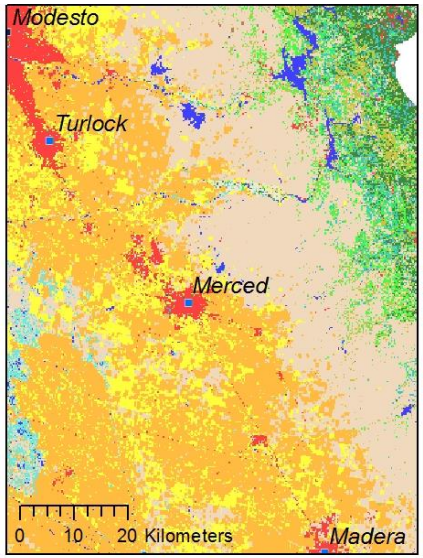
↓

Maps by scenario/year to 2100 at ~250 meter resolution

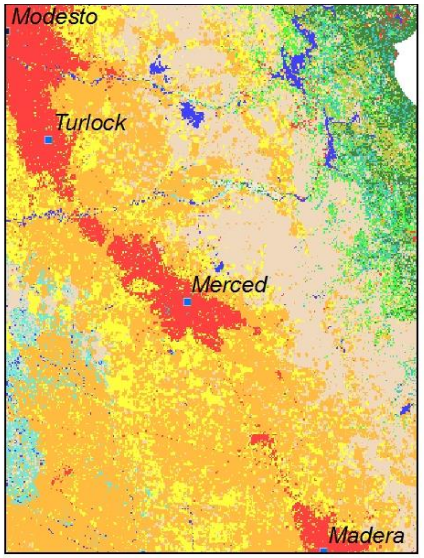


EPA Level III Eco-regions: Central Valley and Chaparral and Oak Woodlands

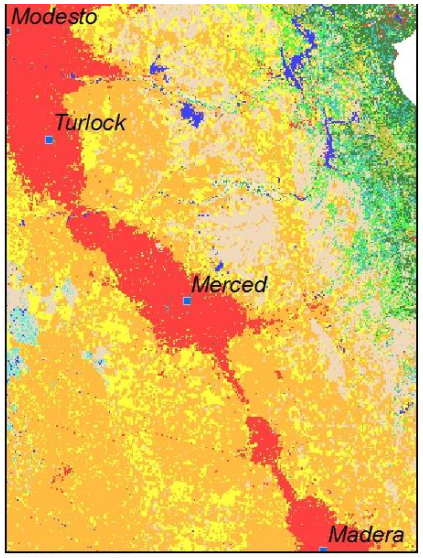
Land-use land-cover change 2006 to 2100; B1, A2, A1B



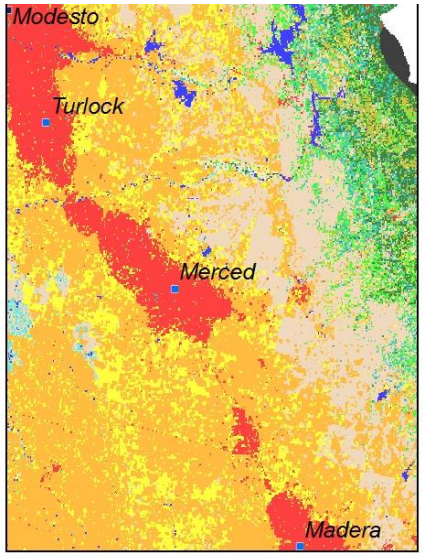
Present-Day



PCM B1 2100
GFDL B1 2100



PCM A2 2100
GFDL A2 2100

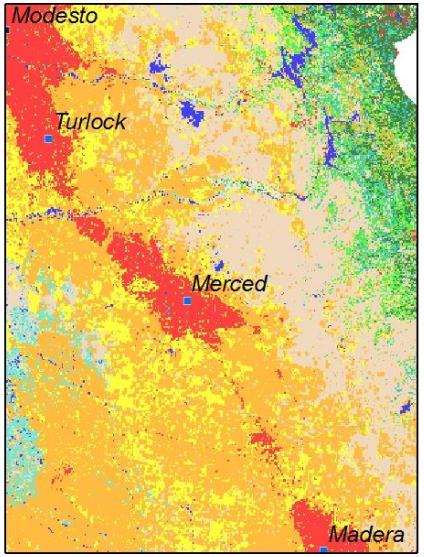


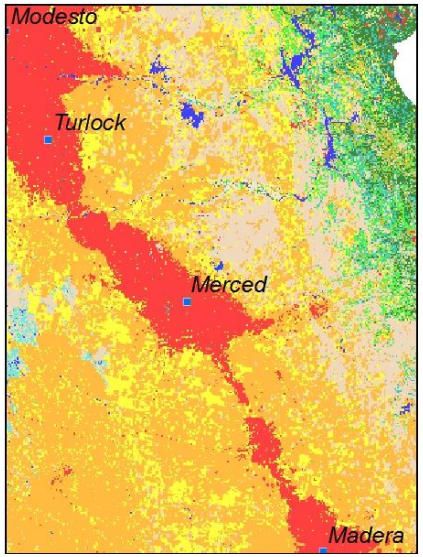
CSIRO A1B 2100
MIROC A1B 2100

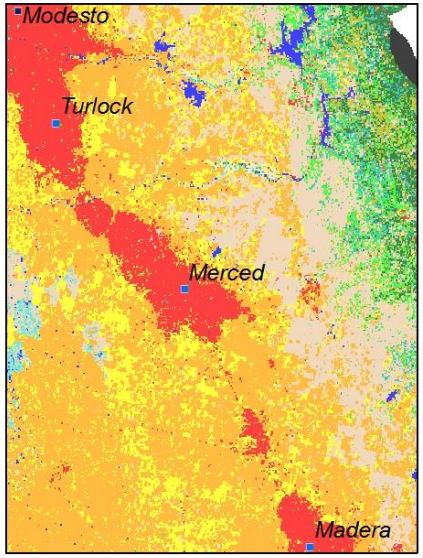
Land use/land cover classes

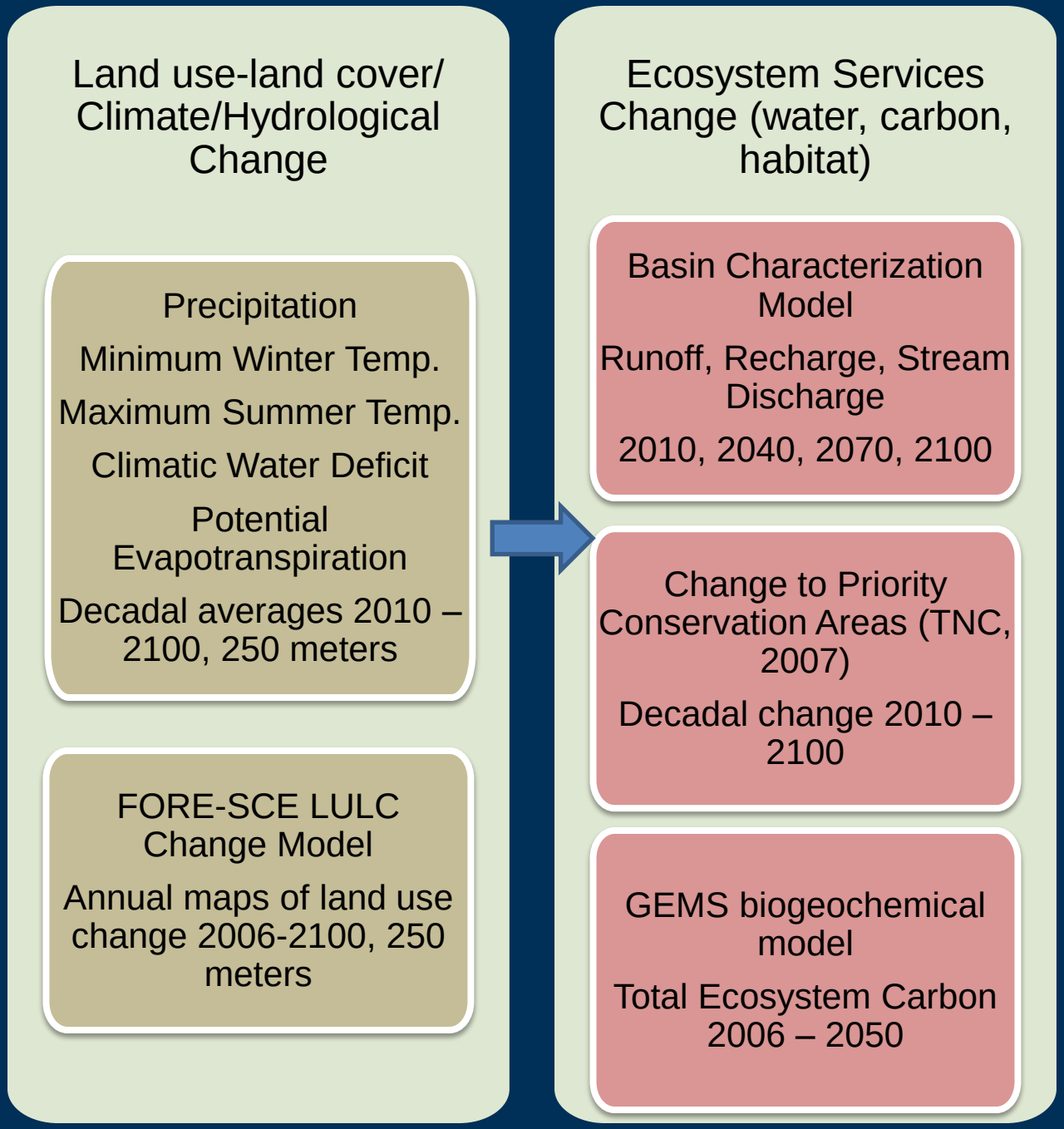
class name

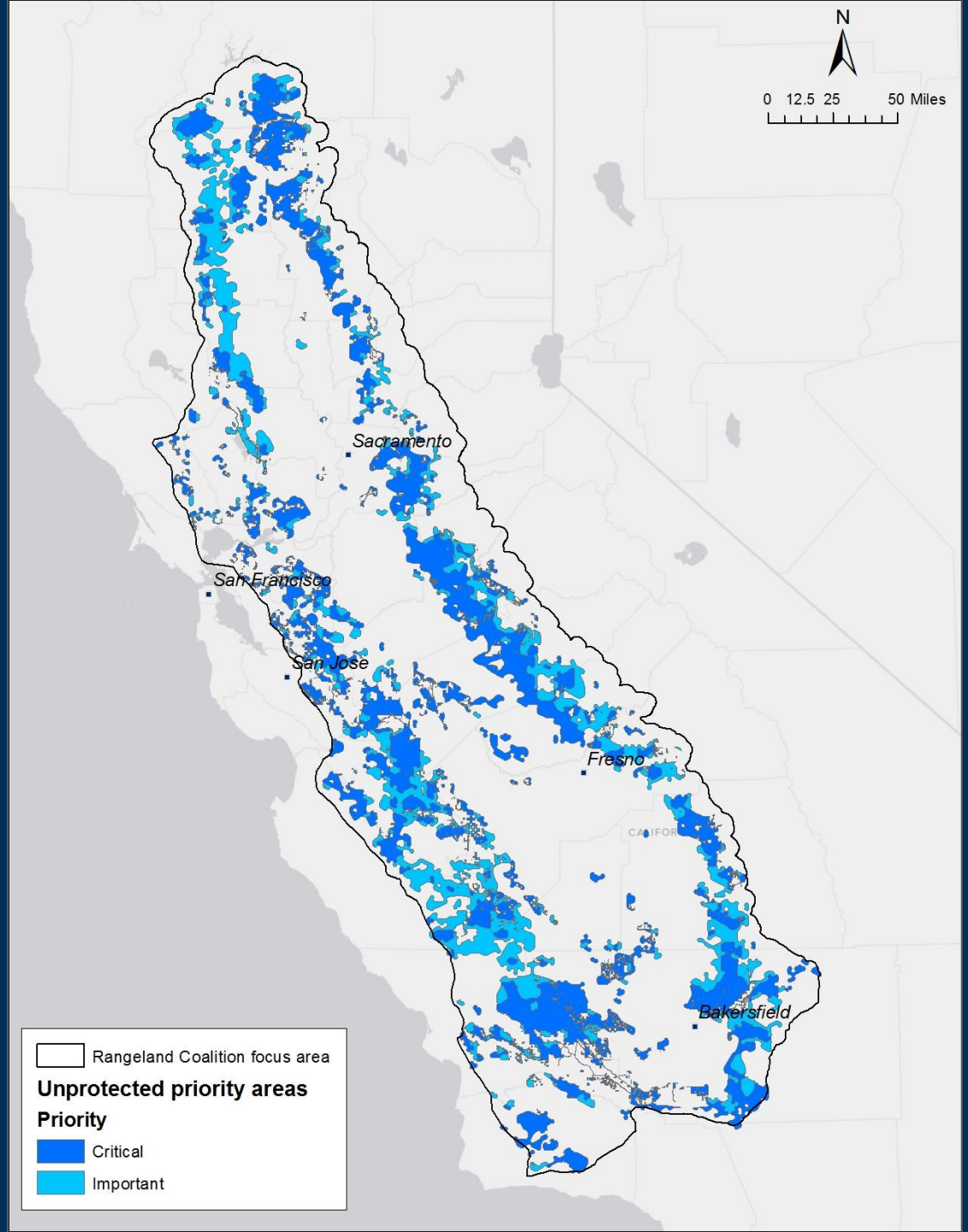
- Agriculture
- Barren
- Deciduous Forest
- Developed
- Evergreen Forest
- Grassland
- Hay/Pasture
- Herbaceous Wetland
- Mech Disturbed NF
- Mech Disturbed OP
- Mech Disturbed PVT
- Mining
- Mixed Forest
- Shrubland
- Water
- Woody Wetland







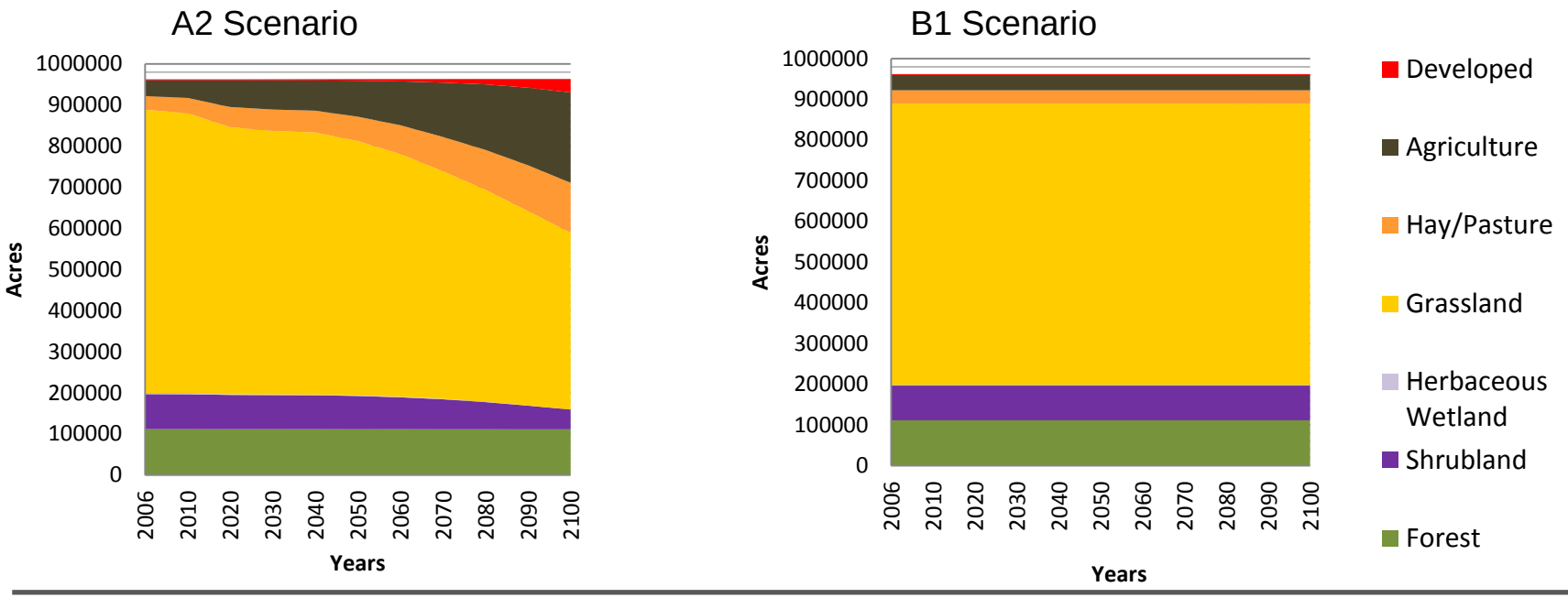

Land use-land cover/ Climate/Hydrological Change
Precipitation
Minimum Winter Temp.
Maximum Summer Temp.
Climatic Water Deficit
Potential Evapotranspiration
Decadal averages 2010 – 2100, 250 meters
FORE-SCE LULC Change Model
Annual maps of land use change 2006-2100, 250 meters
Ecosystem Services Change (water, carbon, habitat)
Basin Characterization Model
Runoff, Recharge, Stream Discharge
2010, 2040, 2070, 2100
Change to Priority Conservation Areas (TNC, 2007)
Decadal change 2010 – 2100
GEMS biogeochemical model
Total Ecosystem Carbon 2006 – 2050



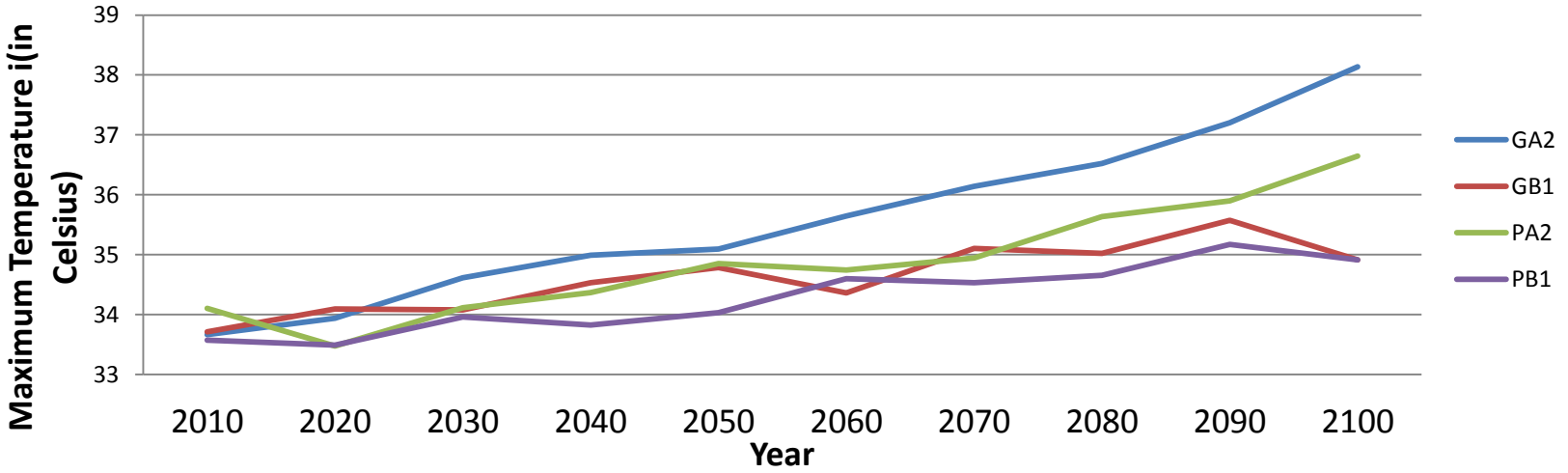
Landscape-level analysis

- Land use/climate change for conservation scenarios
- Water-wildlife hotspots

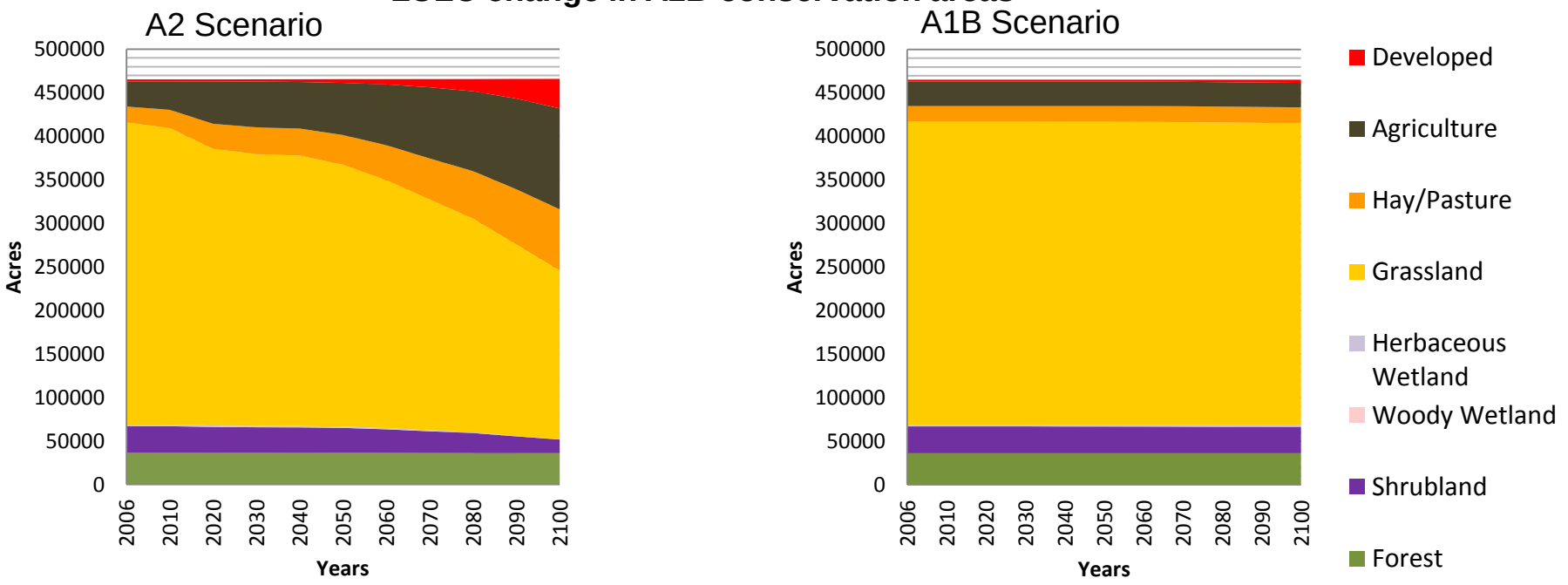
LULC change in B1 conservation areas



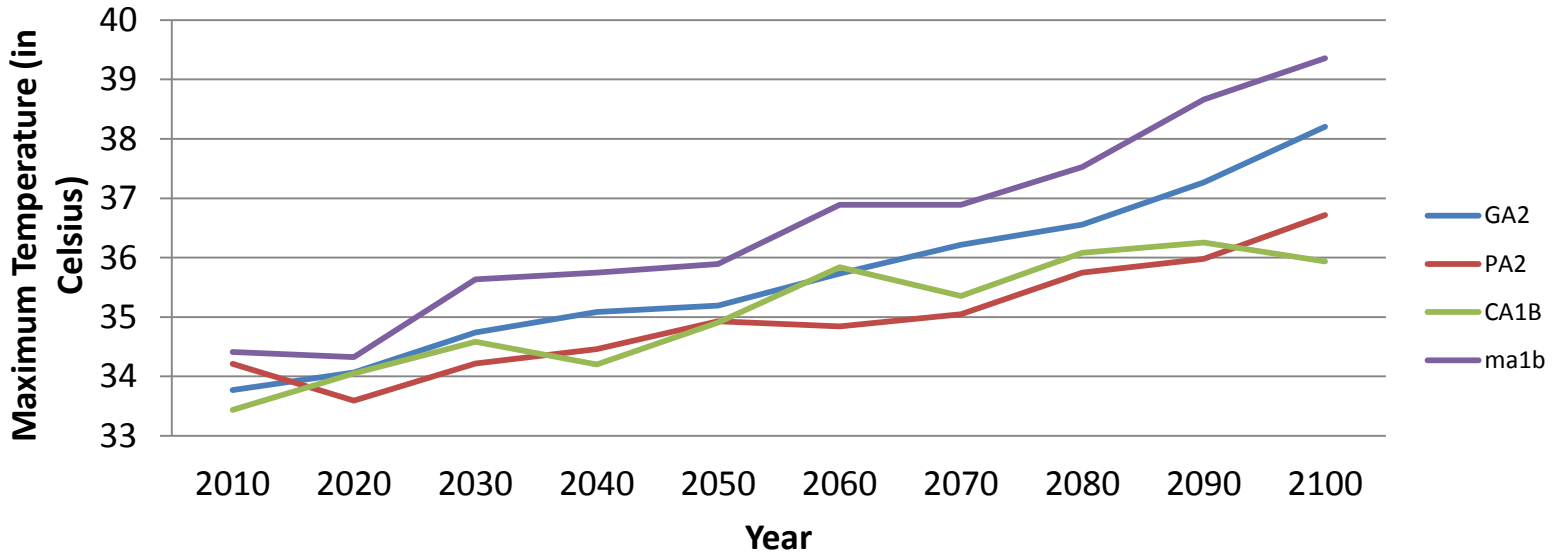
Summer maximum temperature by scenario, B1 conservation areas



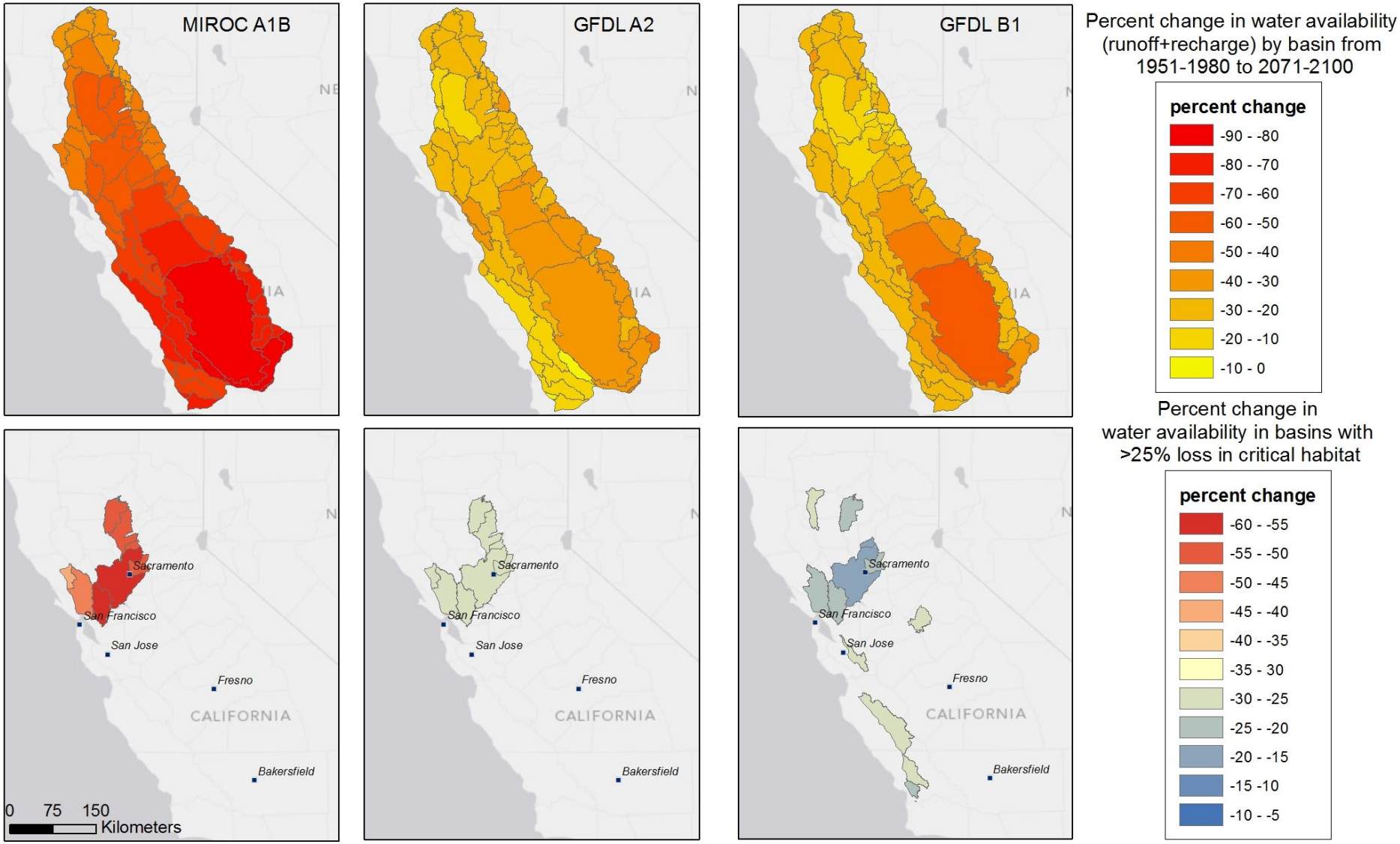
LULC change in A1B conservation areas



Summer maximum temperature by scenario, A1B conservation areas



Water-wildlife hotspots for dry scenarios (draft)



Case Study of Six Watersheds:

North:

Upper Stony
Lower Butte

Central:

Lower Cosumnes
Alameda Creek

South:

Upper Tule
Estrella

Changes in:

- Wildlife habitat
- Carbon
- Runoff, recharge, streamflow

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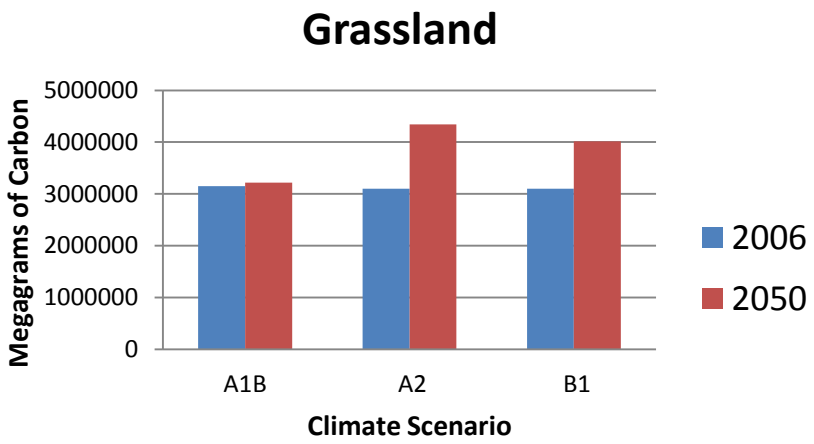
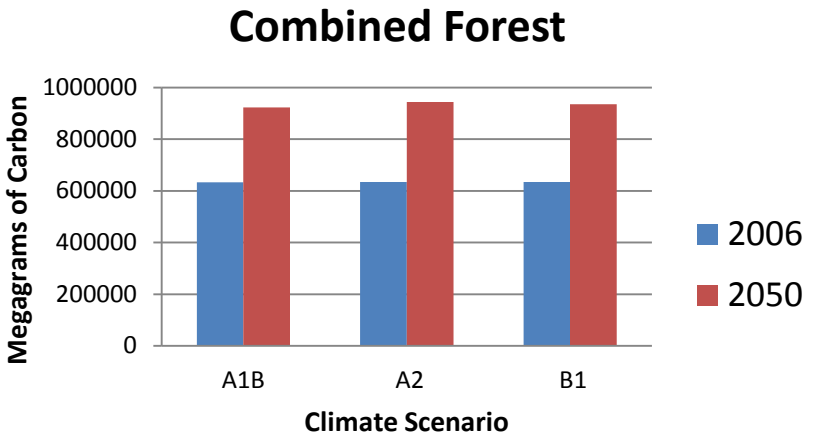
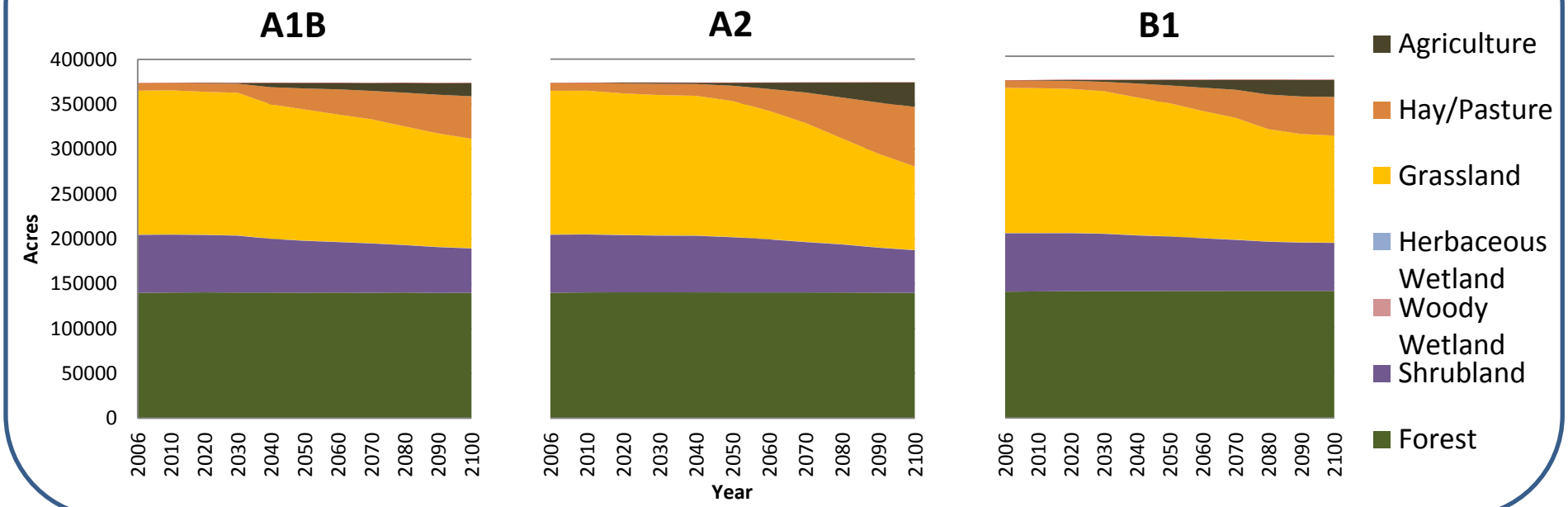
Change in Total Ecosystem Carbon - Upper Stony Watershed

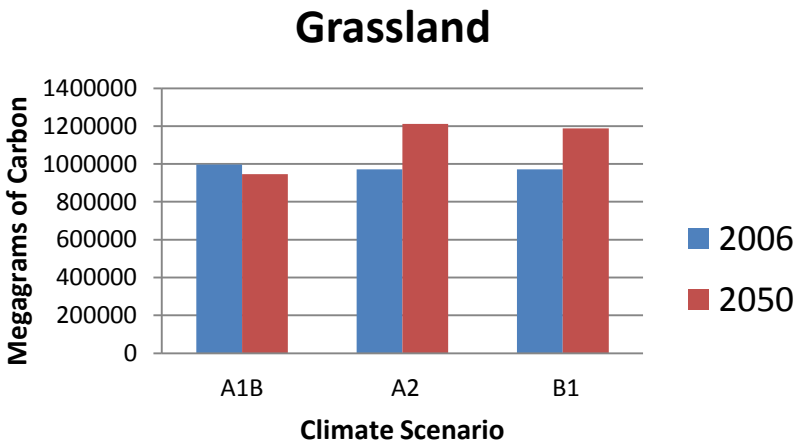


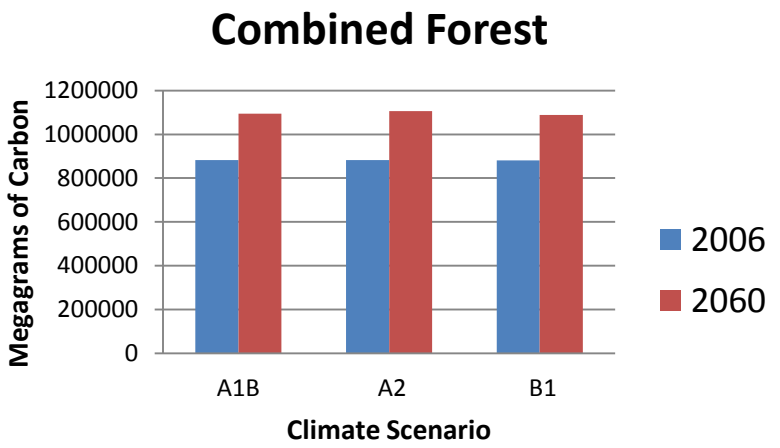


Habitat Change - Upper Stony Watershed

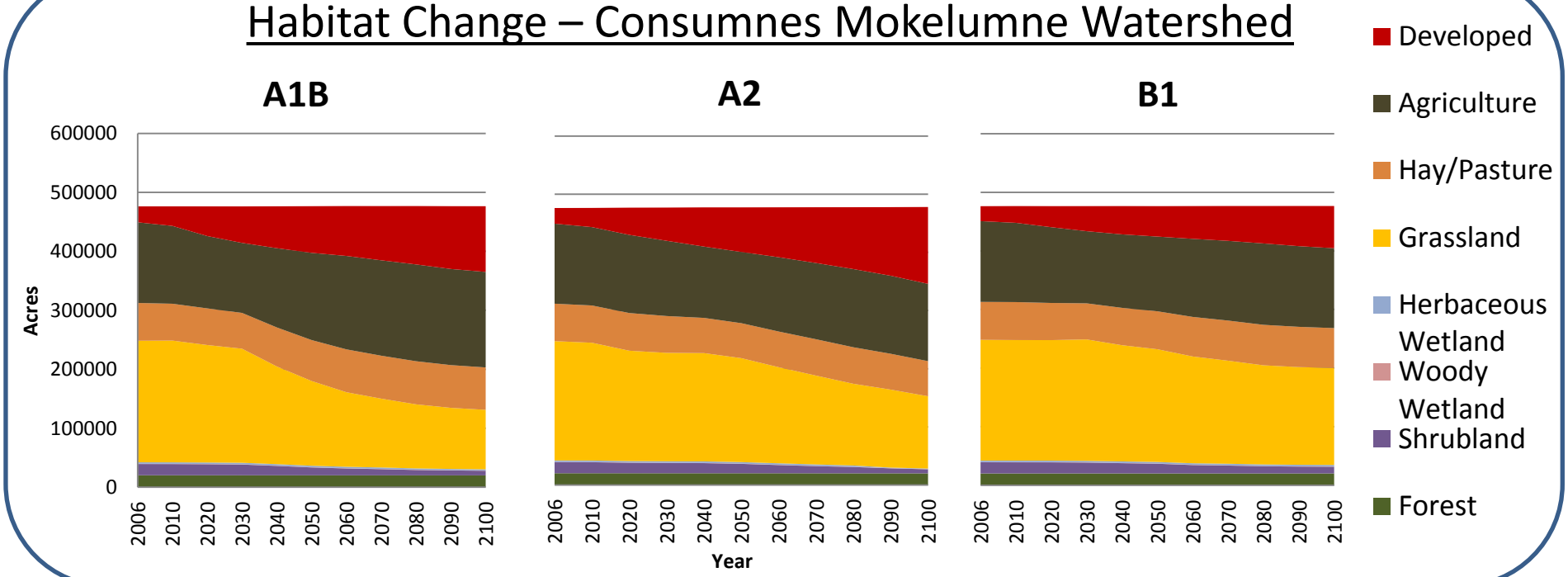


Change in Total Ecosystem Carbon – Consumnes Mokelumne Watershed

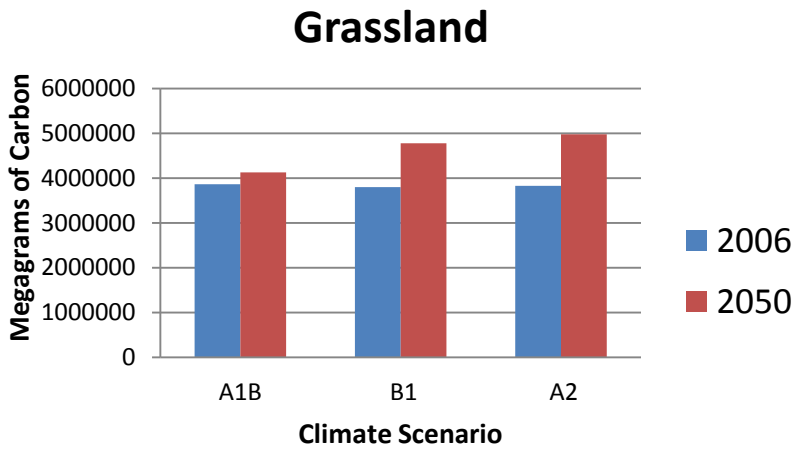


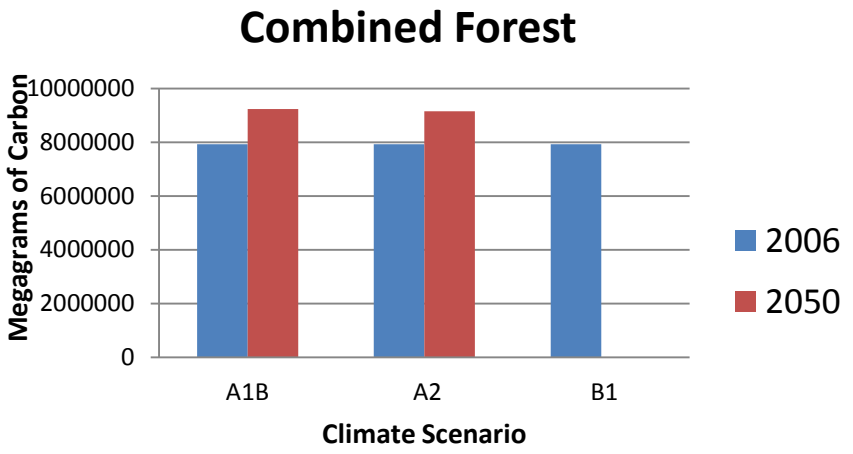


Habitat Change – Consumnes Mokelumne Watershed

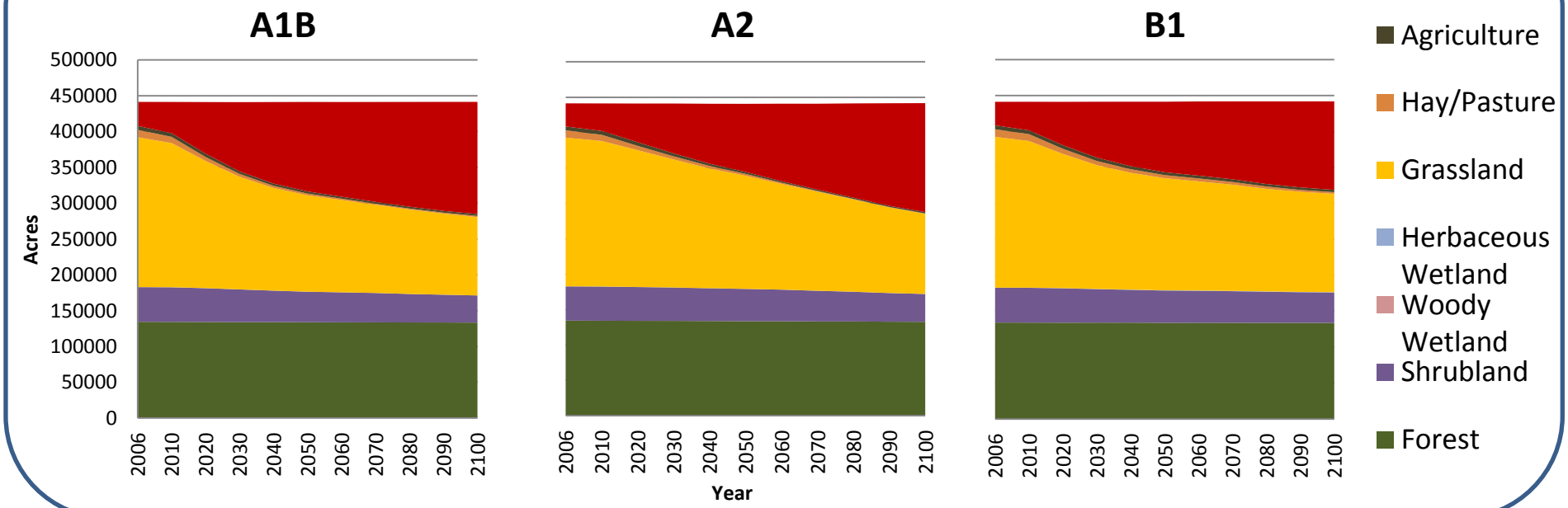


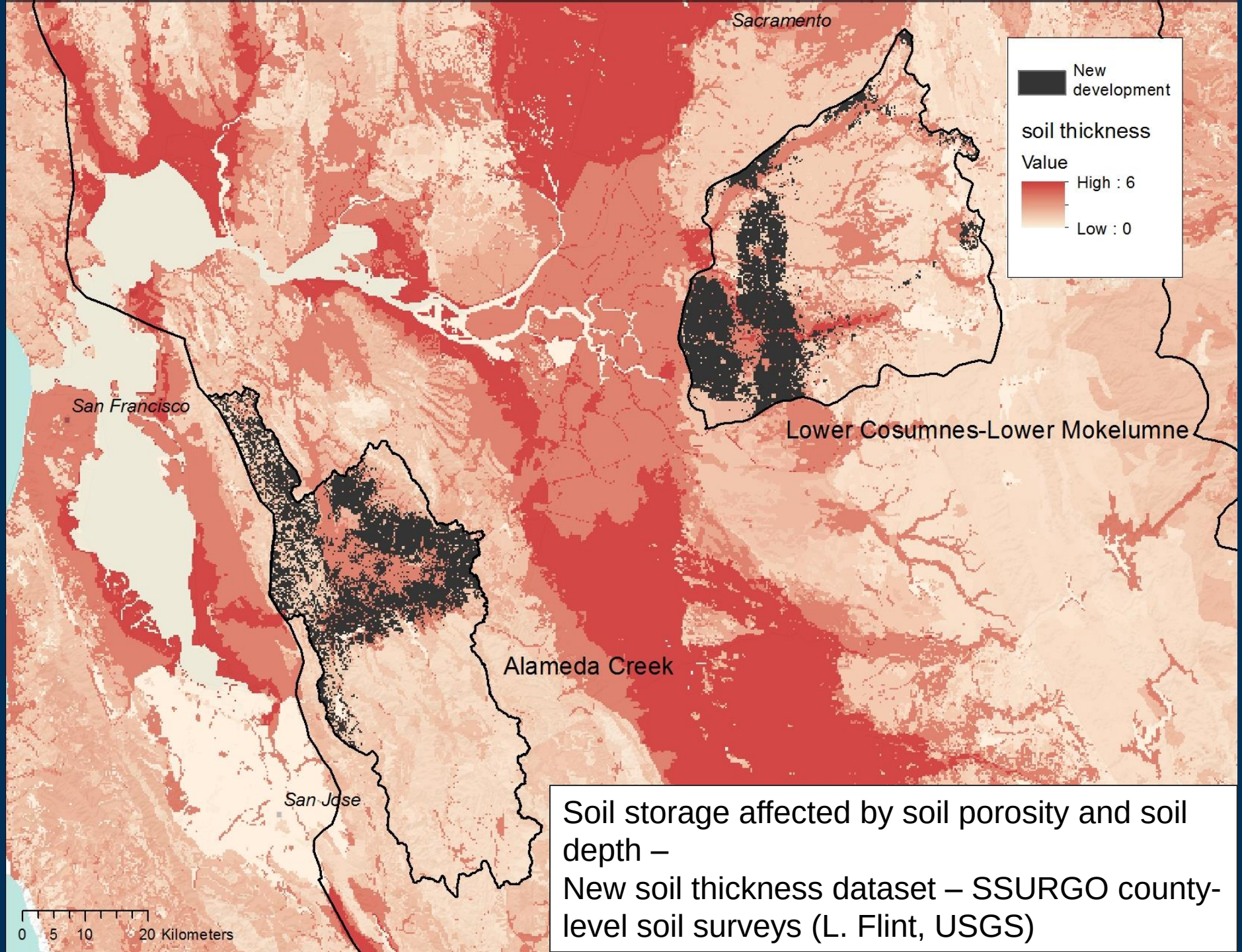
Change in Total Ecosystem Carbon – Alameda Creek Watershed





Habitat Change – Alameda Creek Watershed

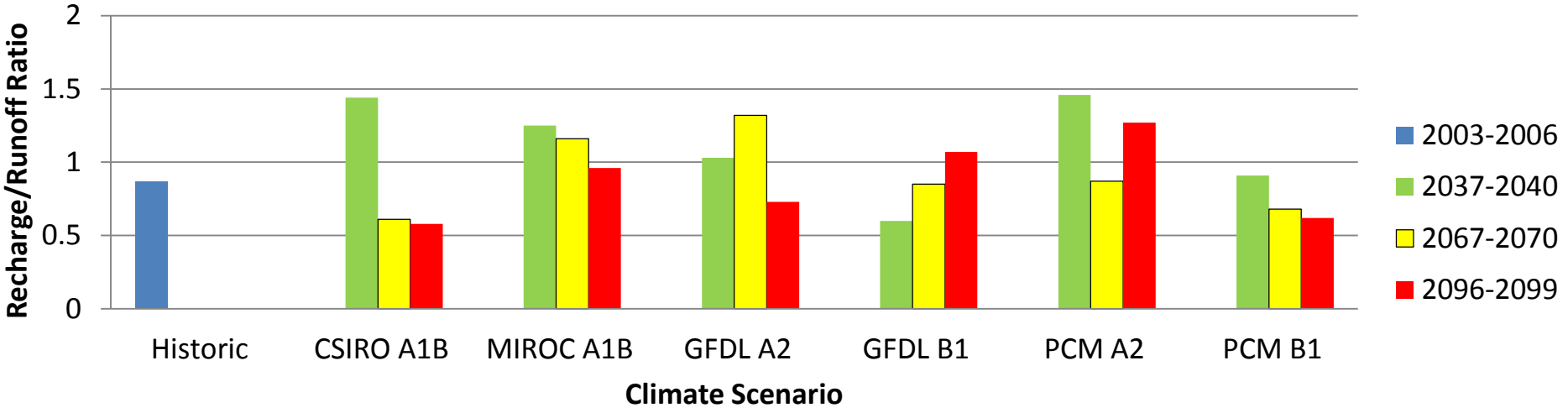




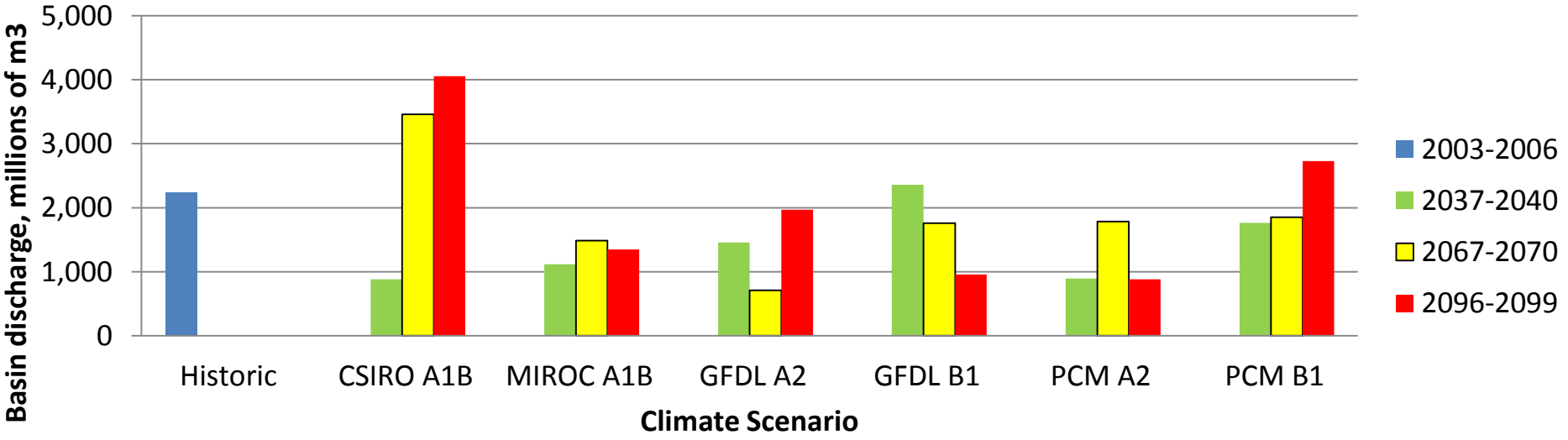
Soil storage affected by soil porosity and soil depth –
New soil thickness dataset – SSURGO county-level soil surveys (L. Flint, USGS)

Upper Stony Watershed

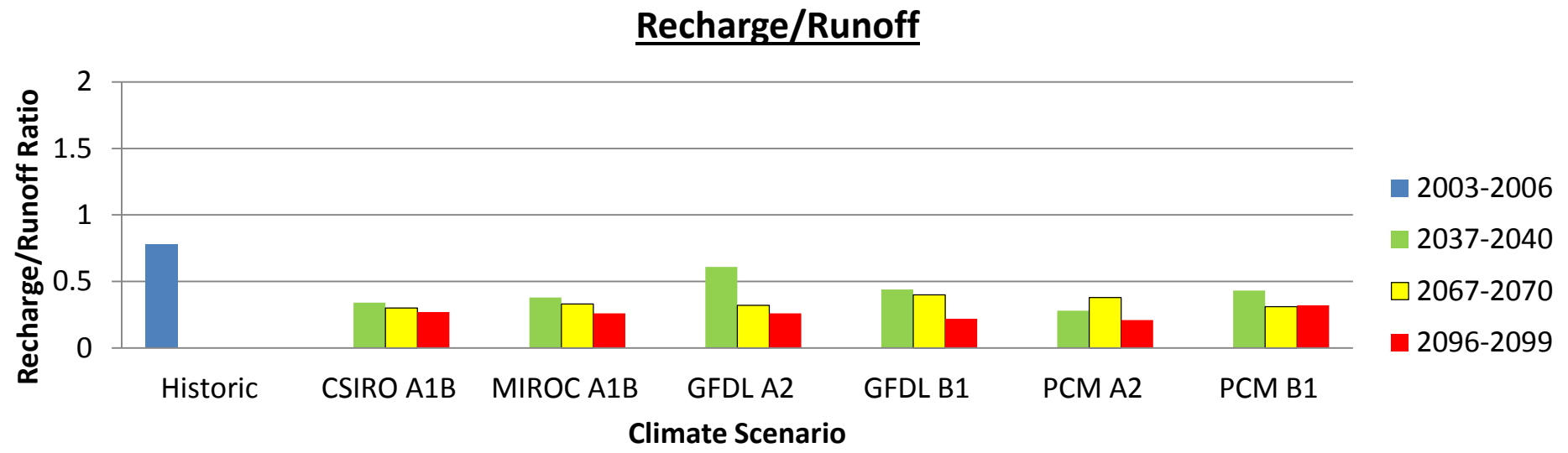
Recharge/Runoff

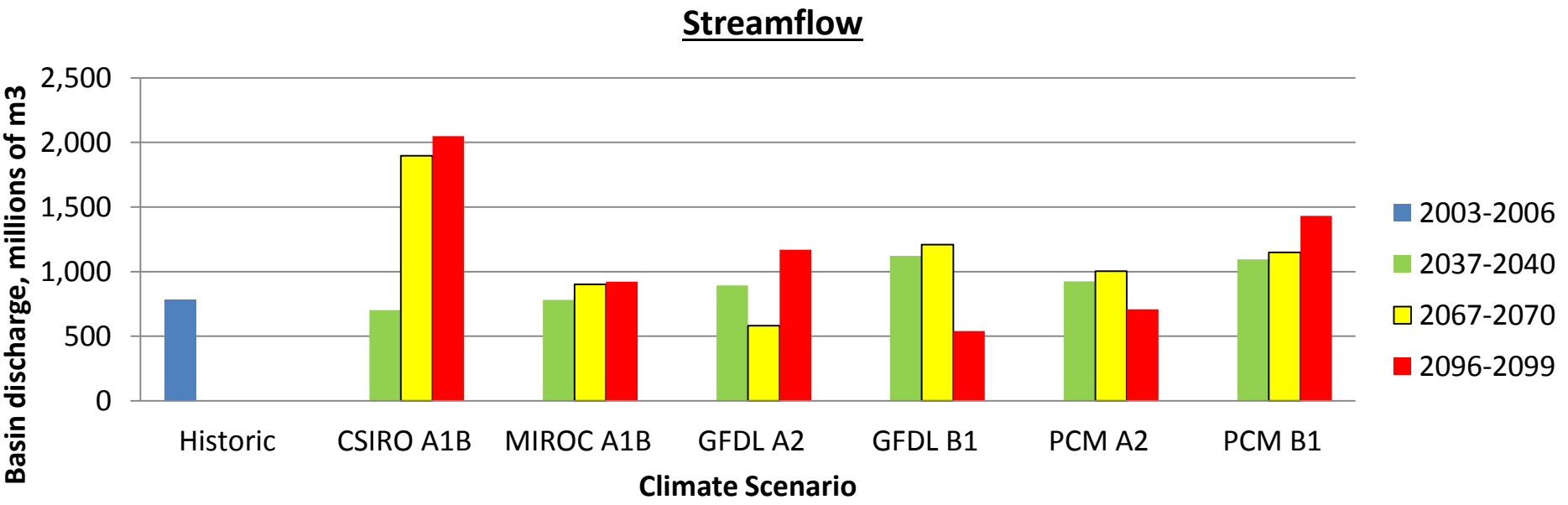


Streamflow

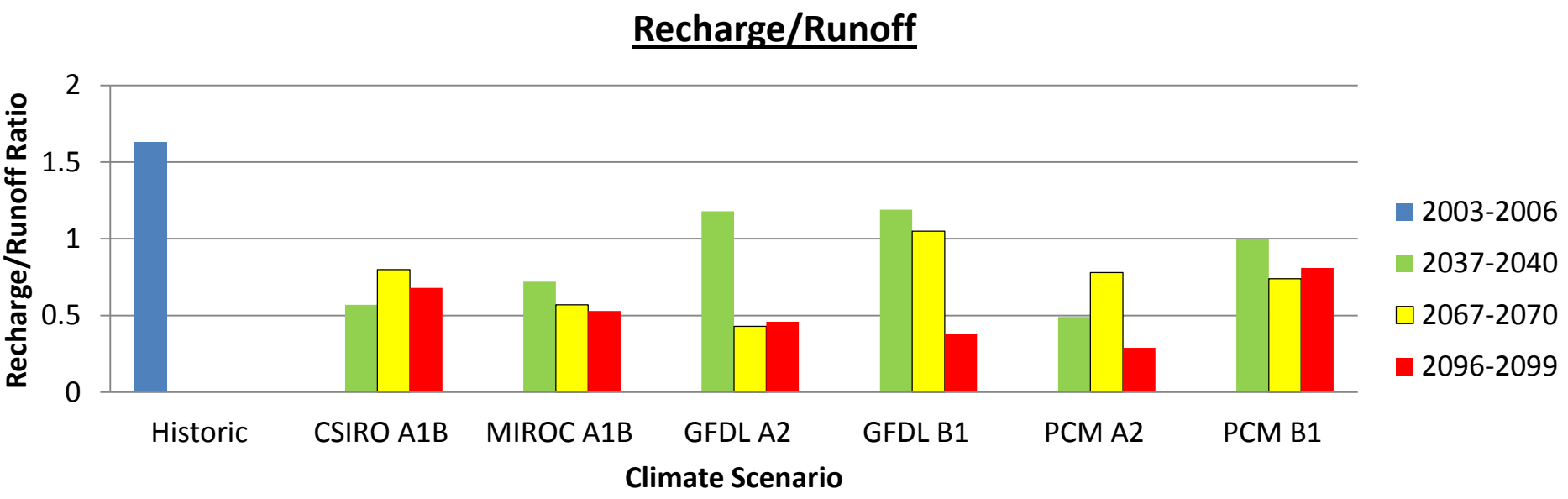


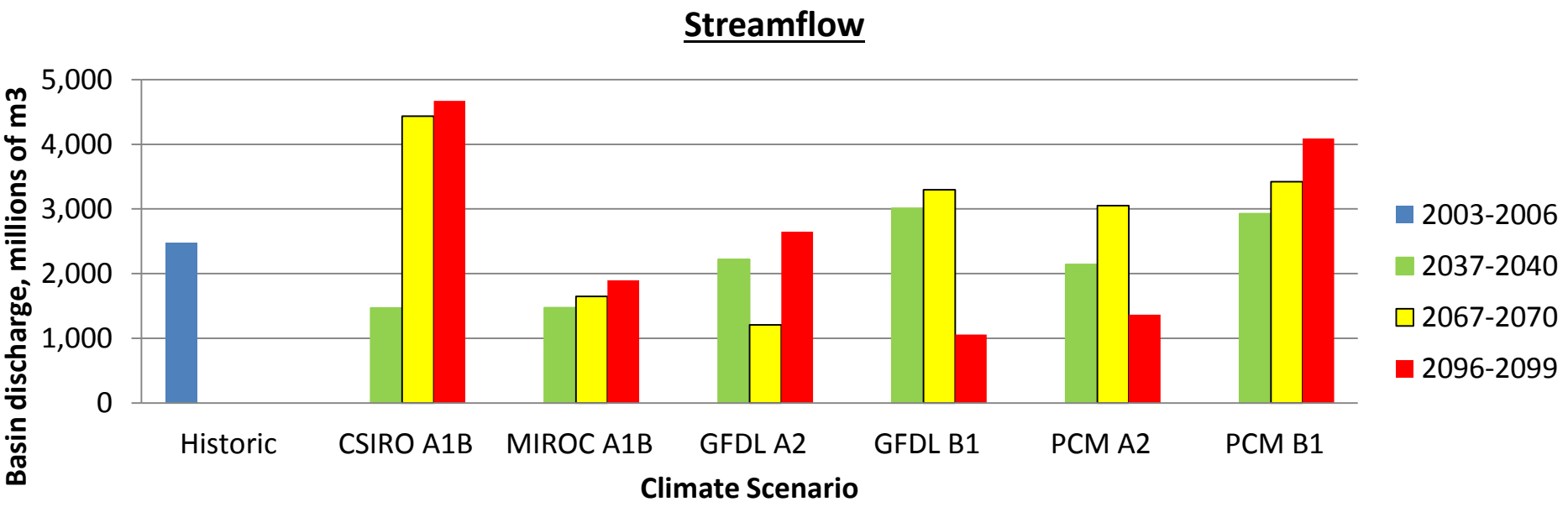
Alameda Creek Watershed





Consumnes Mokelumne Watershed





Summary

- Potential for C sequestration decreases with area and rate of grassland conversion
- The ratio of recharge to runoff decreases with increasing urbanization (Alameda, Cosumnes)
- Amount of change depends on current soil storage capacity, more change if urbanization on deep soils
- In non-urbanized watersheds, ratio of recharge to runoff can increase in dry years (Upper Stony)
- Has implications on water resource planning – water supply and habitat and need to plan for extreme events

Outreach

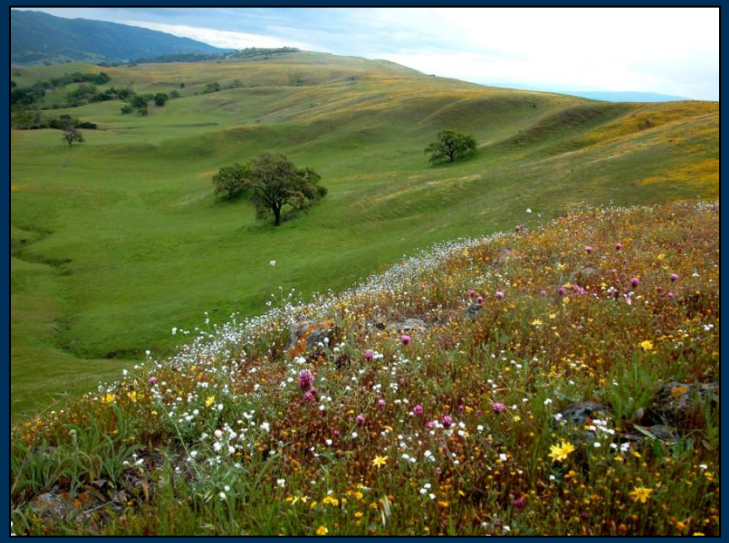
a) Key messages:

- Inform stakeholders of impacts of climate change and land use change to rangeland ecosystem services
- Decision-making tool for prioritization of climate change mitigation strategies (i.e restoration sites, conservation easements)
- Raise awareness about the importance of rangelands in providing ecosystem services

b) Targets

- Ranches and land managers
- Government agencies
- Non-profits: Ag and conservation organizations
- Others: researchers, planners, legislators, general public

Acknowledgments



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Funding by the California Landscape Conservation Cooperative

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