Biol 420/620

Ecological Monitoring

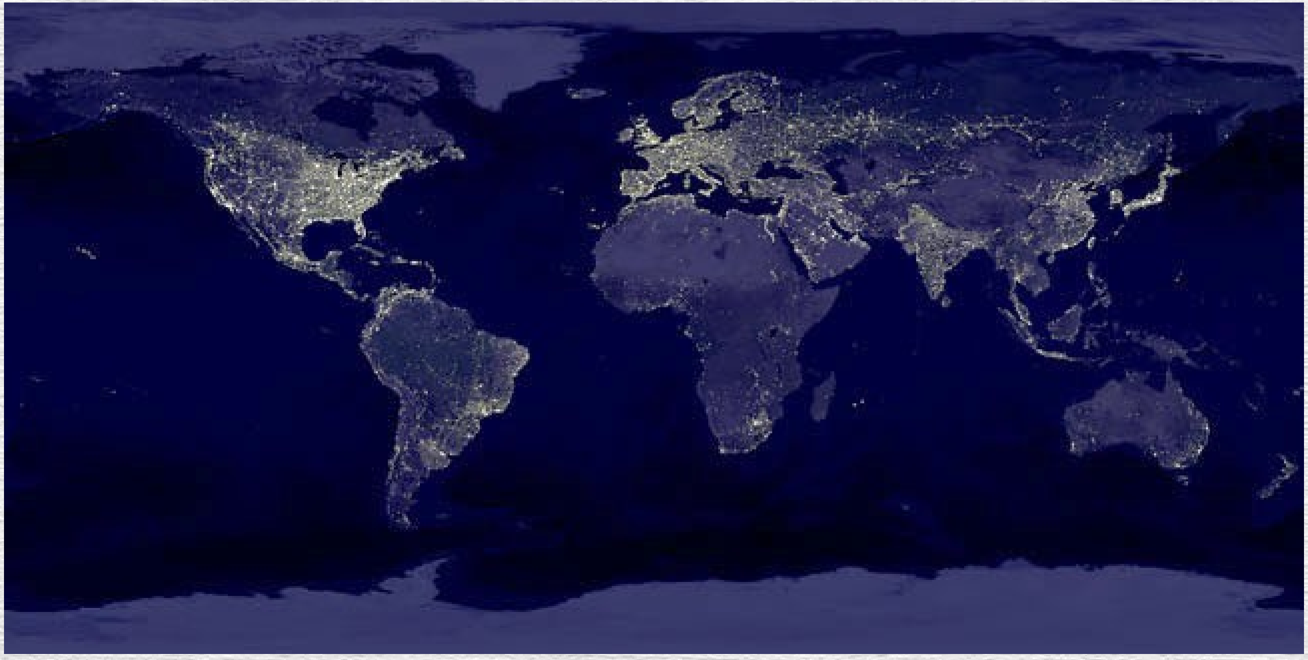
We're changing the world

- Human population is growing
- Our lifestyles are increasingly consumptive
- Land must be converted for human use
  - Agriculture
  - Development
- Energy use is high
- All of this is drastically changing the world, in ways that are threats to ourselves and other species

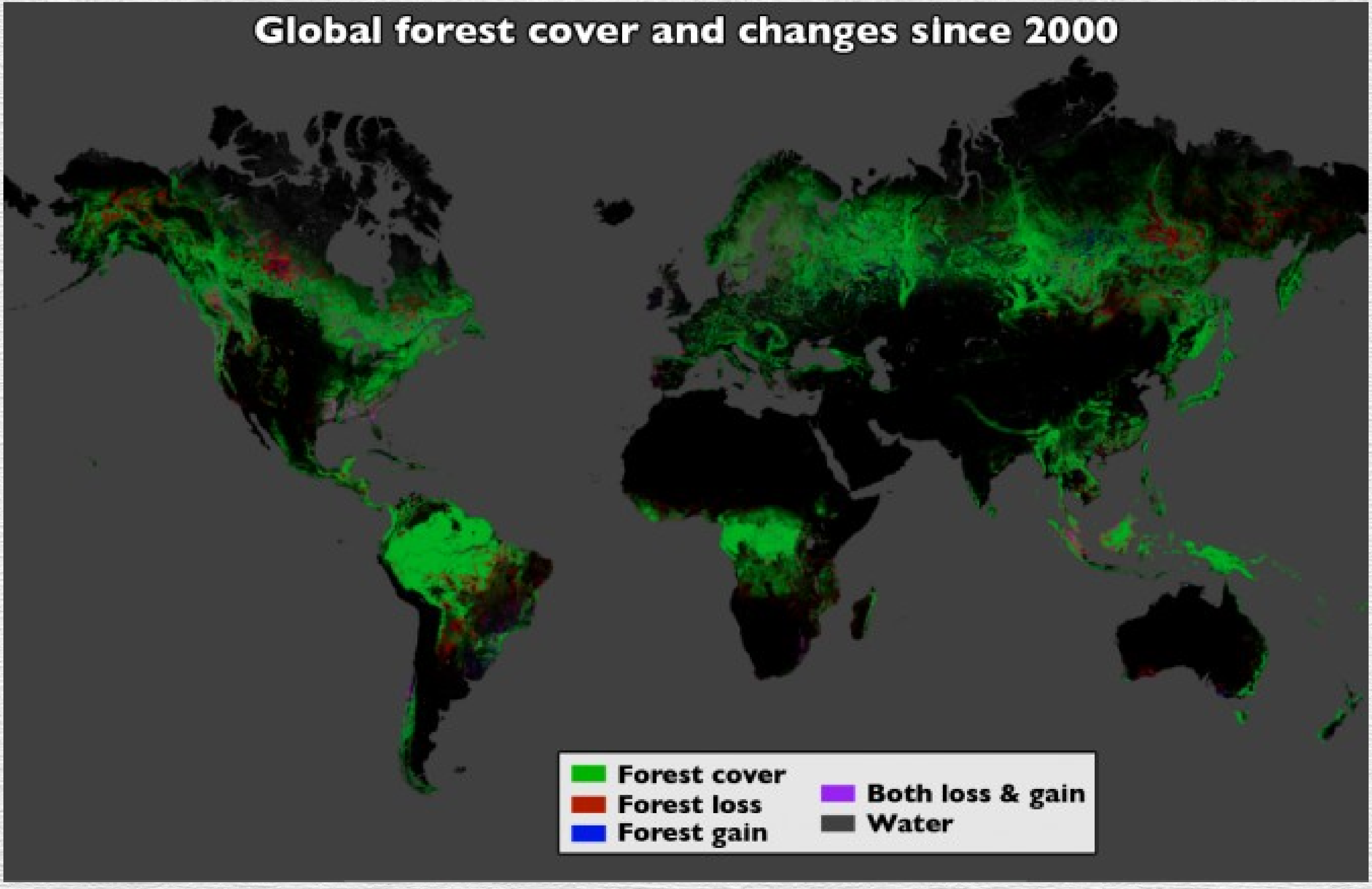
Development, urbanization

http://landcover.usgs.gov/urban/umap/movies/sf_bay450.mpeg

http://www.youtube.com/watch?v=9_9SutNmfFk



http://earthenginepartners.appspot.com/science-2013-global-forest

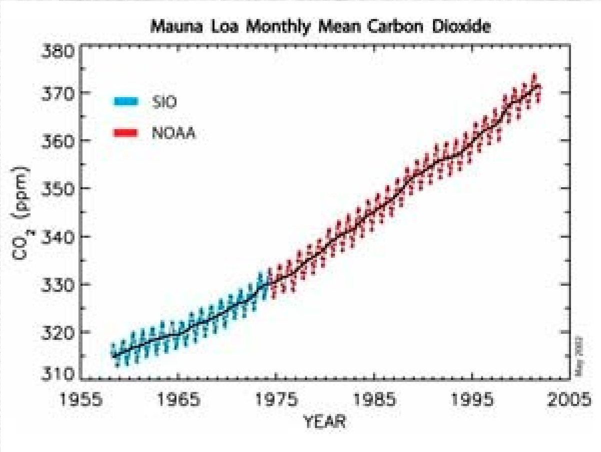


Climate change

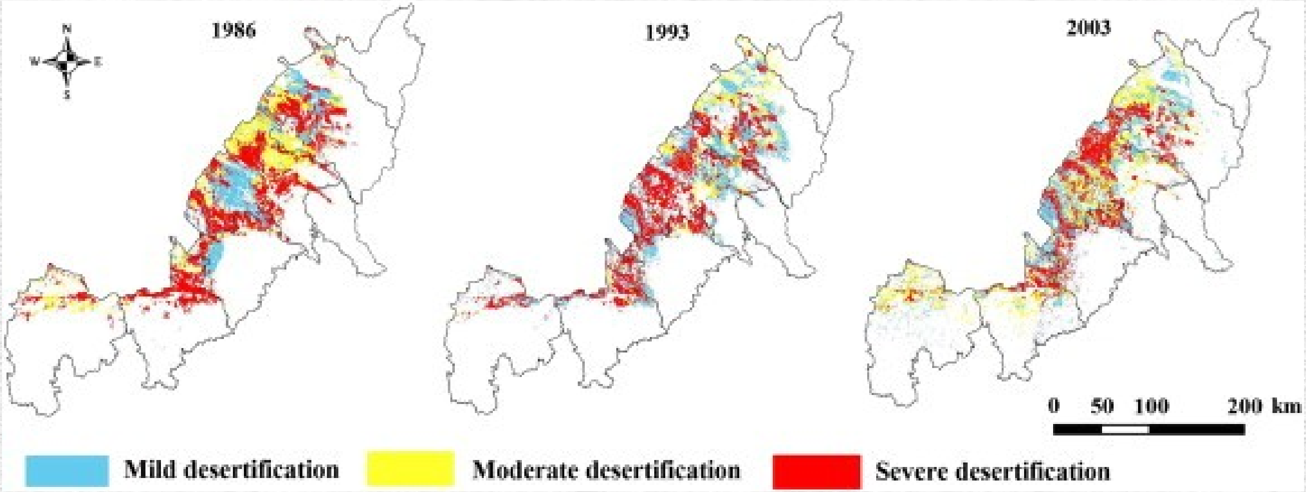
http://earthobservatory.nasa.gov/Features/WorldOfChange/decadaltemp.php

http://www.youtube.com/watch?feature=player_embedded&v=l8tPKj20GFo#at=17

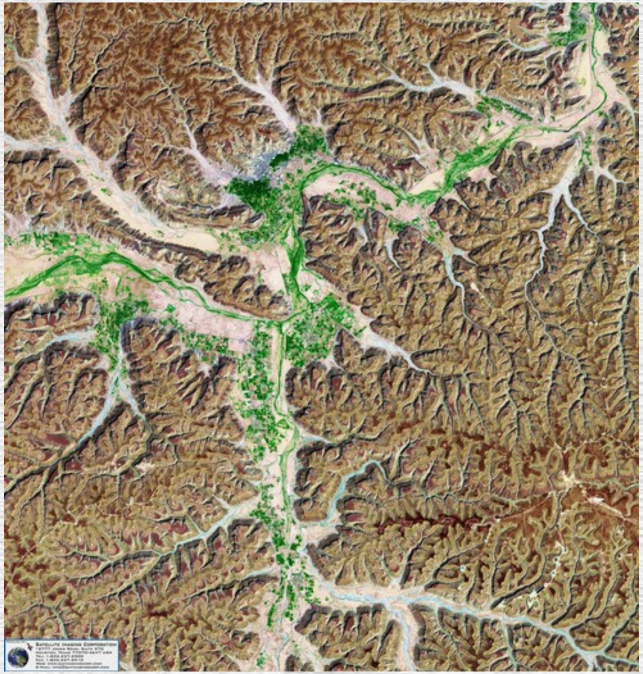
Muana Loa Observatory



Desertification

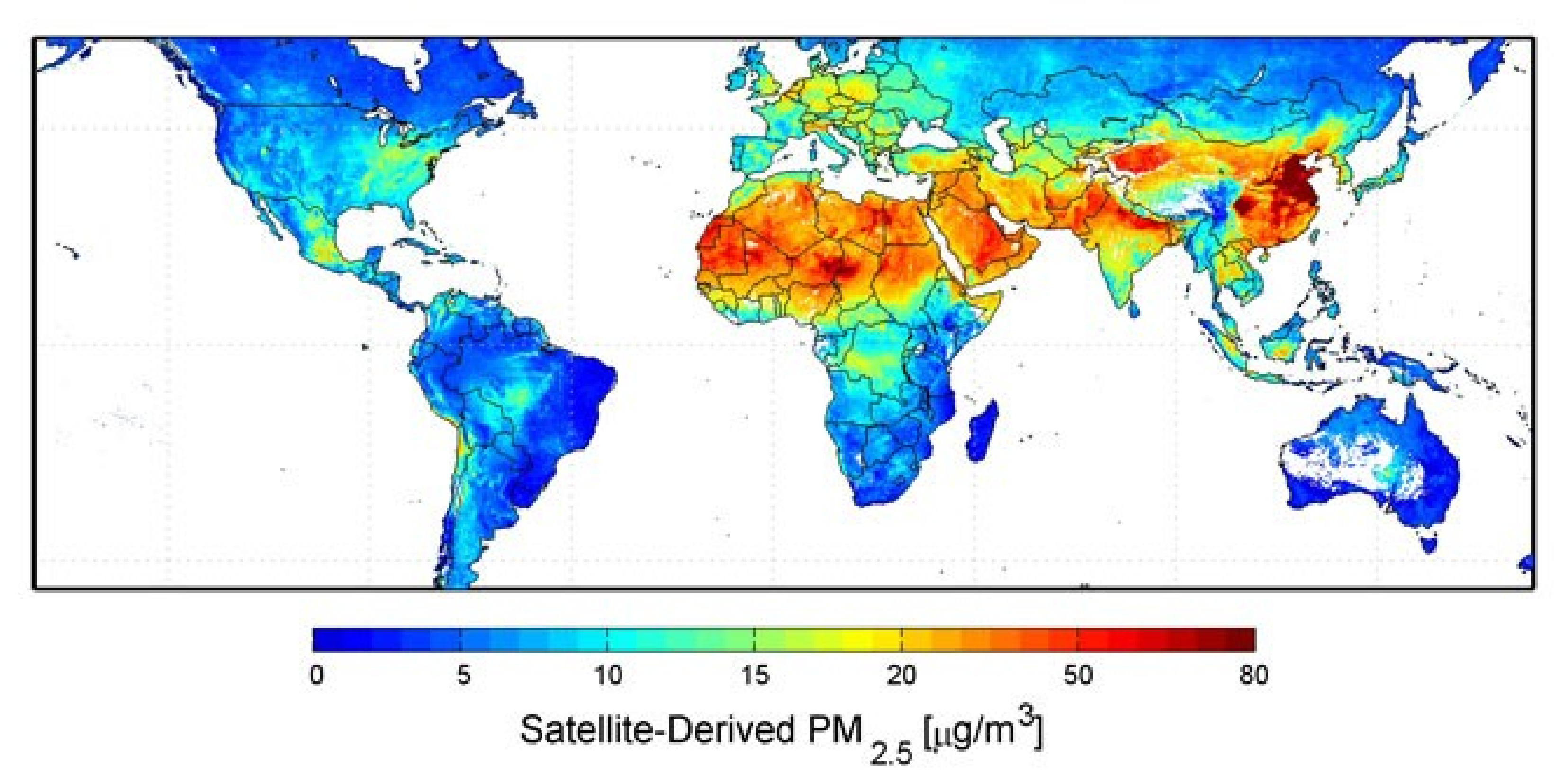


A portion of northern China



Yemen

Atmospheric pollution



Satellite-based estimates of particulate matter from 2001-2006

The biodiversity crisis

- Species become threatened, endangered, or extinct due to:
  - Anthropogenic development → habitat destruction
  - Invasive exotic species → native species displaced
  - Direct consumption → over-harvesting
  - Pollution → habitat degradation
- Combined, these impacts are leading to loss of species, which reduces biodiversity
- The current rate of species loss is more similar to mass extinctions (e.g. dinosaurs) rather than to normal “background” species loss (~1 sp./yr out of the estimated 5-30 million worldwide)

Monitoring change

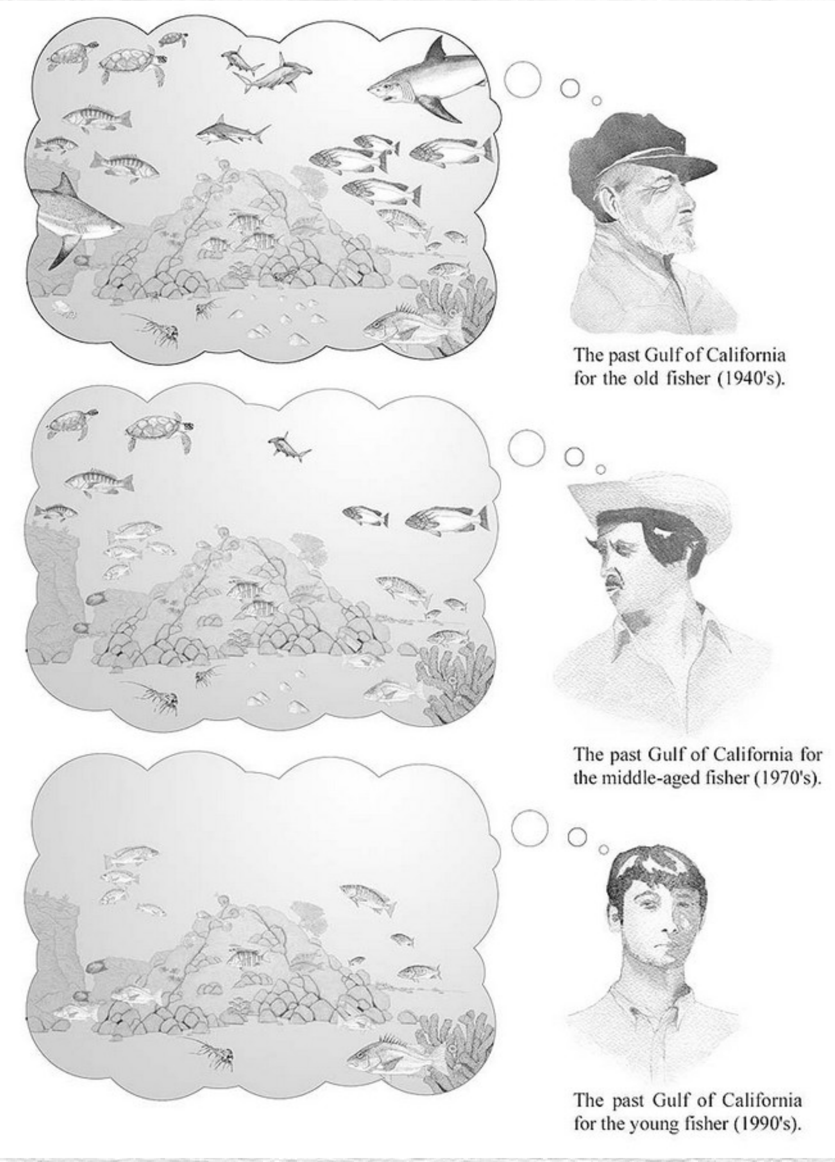
- Recording conditions, and detecting change over time
- Allows us to intelligently address:
  - Sustainable resource management
  - Climate change
  - T&E species conservation
- Status and trend
  - Status = current conditions
  - Trend = change over time

Personal perception of change isn't enough

- We need to be data driven
  - Cumulative effects = impacts that accumulate over time
  - We're poor at detecting changes over large spatial scales, long time scales
- Our personal perceptions of the problems are biased by personal experience
- E.g. the "shifting baselines problem"

Shifting baselines

- Human lifespans are usually less than 100 yrs
- Changes have been occurring longer than the average human lifespan
- To us, changes over decades seem slow, but are extremely rapid in evolutionary/ecological sense
- Conditions as they are when we become aware of them are our “baseline”, treat them as normal
- Unaware of the changes that have already occurred, we don’t realize what has already been lost
- We need to monitor to know better



Monitoring natural resources and services we depend on

- Need to ensure that our use is sustainable
- Ecosystem services
  - Clean air, water
  - Fertile soils
  - Pollination of crops
- Resources
  - Wood products
  - Food (fish)
  - Genetic resources

Monitoring changes that occur without direct interaction with people

- Changes happen even within parks and reserves
  - Invasive exotic species enter from the outside
  - Changes in water flow into the park
  - Pollution
  - Fire
  - Climate change
- Intervention to prevent damage is more likely to work the earlier we intervene
- Monitoring allows us to detect problems before they get out of hand

Monitoring for changes

- To detect change in a population, community, or ecosystem over time, we need to:
  - Define the system to be monitored
  - Decide what property(ies) to record and/or quantify
  - Decide where and when to sample
  - Collect the data
  - Compare the measurements between time points to determine if there are changes

Qualitative properties

- Qualitative = a property of a system that isn’t represented as a numeric quantity
  - Vegetation type
  - Species composition
- Can monitor for these kinds of changes as a change in state
  - A single location that changes vegetation type
  - Loss of (native) species, gain of (exotic) species

Quantitative changes

- Quantitative = a property that can be represented as a numeric quantity
  - Area of cover, primary production of a vegetation type in a region
  - Abundance of a species
  - Species composition of an ecological community
- Quantitative changes can be assessed using statistical tools for detecting trends (e.g. regression, time series analysis)
- The quantities measured should clearly be reliable indicators of the health, stability and proper functioning of the system

Our focus: land cover change, population monitoring

- Land cover change is a reliable indicator of changes in populations, communities, and ecosystems
- For particular species of interest, we can also monitor populations
  - Abundance, density
  - Population growth rate

Land cover change

- Land cover = the physical material at the surface of the earth
- Many types of land cover can be observed from the air, or from space
- Land cover types can be defined to correspond to habitat types
- Change in land cover is then a useful proxy for change in habitat
  - Change from vegetation → development is habitat loss
  - Change from grasslands → forest is habitat change
- Over large spatial scales, this kind of monitoring is usually done with remote sensing and GIS

Example: Los Peñasquitos Creek

- Change in hydrology → change in cover type
- Changes in habitats → changes in species composition, ecosystem function

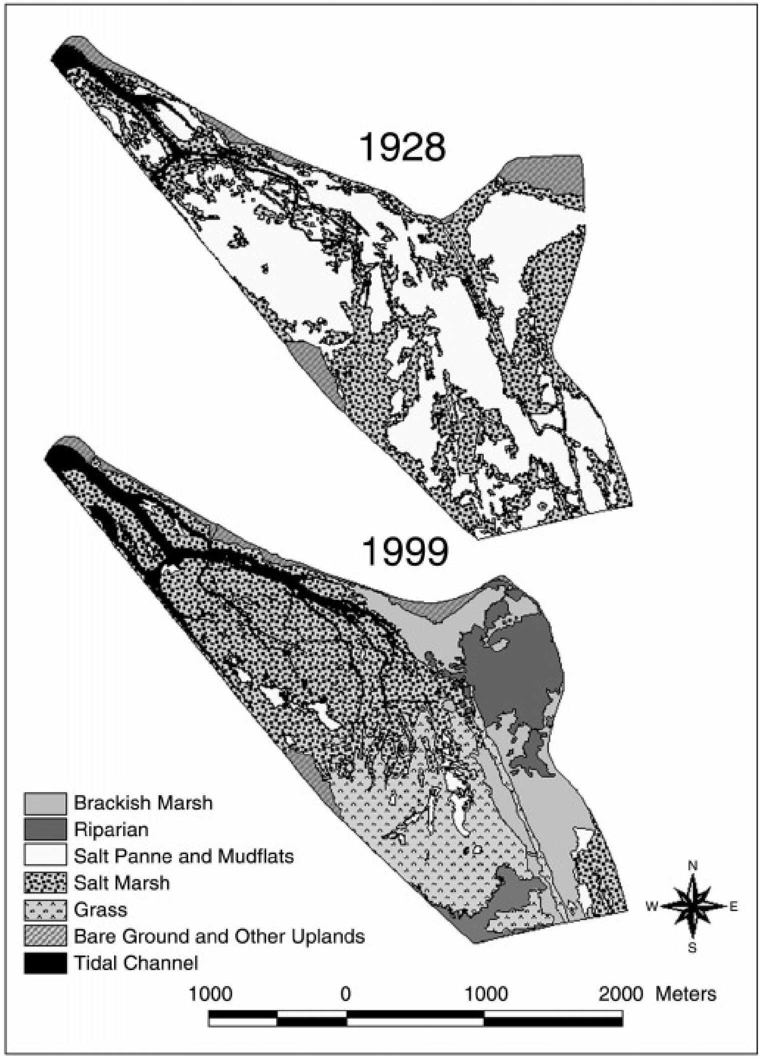


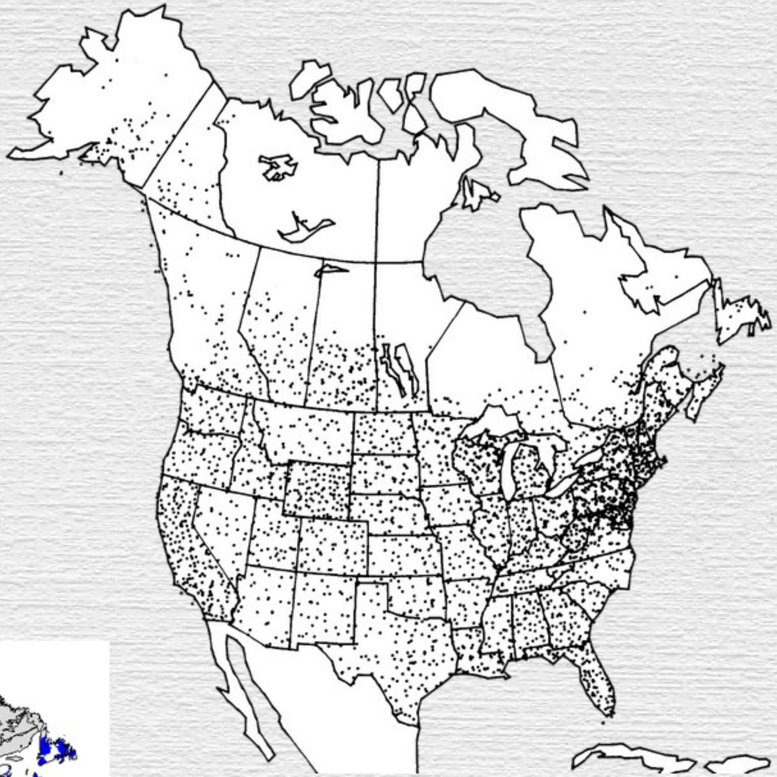
Figure 4. Generalized vegetation types for the Los Peñasquitos Lagoon study area for 1928 and 1999.

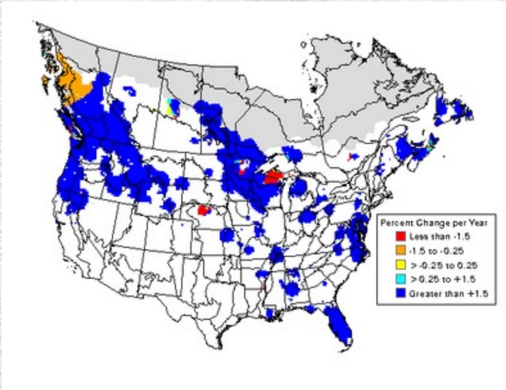
Monitoring populations

- For single species (e.g. a T&E species), focus on more detailed, field-based data collection
- Abundance and/or density – the number of individuals, or number per unit area
  - Single assessment – status
  - Changes in abundance or density over time – trend (population growth rate)
- Demographic monitoring = using birth and death rates to calculate population growth rate

Monitoring abundance

- Breeding Bird Survey (BBS)
- Routes observed each year at the same time
- Changes over time indicate changes in abundance





Bald Eagle recovery

Demographic monitoring

- Calculating population growth rate from age- and sex-specific birth and death rates

- Very informative, but very labor intensive

The game plan:

- First 6 weeks – cover type change
  - Remote sensing and GIS
- Weeks 6-11 – population abundance and density status and trend
- Weeks 11-13 – demographic monitoring
- Week 14 – biodiversity monitoring