Integration as the key to success
Bridging gaps between ecological research and remote sensing

Ned Horning
horning@amnh.org

http://biodiversityinformatics.amnh.org
Overview

- Observations from the past 30 years
- Not a new topic
- How ecology and remote sensing fit together
- Where are the gaps
- How to strengthen the bridge
- Discussion
Remote sensing and ecology

- Remote sensing: Getting information about an object without physical contact
  - Satellite and aerial platforms
  - Using passive and active electromagnetic sensors

- Ecology: Study of the relations between organisms and their environment
  - Full range of organisms – from nematodes to large mammals
  - Environment scales from local to global
Not a new topic

1969: Remote sensing in ecology
1990: Remote sensing of terrestrial ecosystem structure: an ecologist's pragmatic view
1991: What does remote sensing do for ecology
1993: A remote sensing research agenda for mapping and monitoring biodiversity
2001: Using remote sensing to assess biodiversity
2001: Contributions of remote sensing to biodiversity conservation: A NASA approach
2003: From space to species: ecological applications for remote sensing
2003: Remote sensing for biodiversity science and conservation
2004: Landsat's role in ecological applications of remote sensing
2010: Remote sensing for ecology and conservation
2014: High-resolution satellite imagery is an important yet underutilized resource in conservation biology
Ecological research topics

- Animal movements and home ranges
- Plant and animal species distributions and abundance
- Diversity patterns across spatial and temporal scales
- Environmental effects on species
- Restoration ecology
- Ecosystem function and services
Animal movements and home ranges

- Rapidly growing research area
- Recent advances in tracking hardware and analysis methods
- Interest in broad range of temporal and spatial scales
Plant and animal species distributions and abundance

- Rapid growth in the last 10 years
- Many predictor variables based on remotely sensed data
- Growing interest in finer scale distribution modeling
Diversity patterns across spatial and temporal scales

- Benefits from landscape and global views
- Not easy to do before the satellite era
- Knowledge of patterns becoming more refined

*World map of color coded density of vertebrate species*
Environmental effects on species

- Predicting climate change effects is a major focal area
- Trends often based on historic remotely sensed data
- Adapting to changes in climate

http://www.biodiversityinfo.org/
Restoration ecology

- Monitor and predict ecological change after a significant disruptive event
- A major focus is post-fire regrowth predictions and monitoring

http://egsa.ucdavis.edu/blog/2013-10-21-rimfire/
Ecosystem function and services

- Payment for ecosystem services becoming more important
- REDD+ is funding remote sensing research and training
- Cost of providing accurate fine scale information still a problem
Remote sensing research topics

- Fractional cover mapping
- Habitat structure
- Fine resolution production products
- Multi-temporal image compositing
- Surface reflectance
- Biomass mapping
- Land cover change over time
- New satellite sensors
- Portable aerial platforms
Fractional cover mapping

- Often called percent cover or continuous fields
- Much initial work focused on impervious surfaces
- Recent global map of forest cover
- Provides cover density not available in categorical maps
Habitat structure

- Often derived using active lidar and radar instruments
- Provides 3-D structure data not available from passive systems
- Most lidar sensors on aircraft
- Recent increase in satellite radar systems
Fine resolution global products

- Global products available at 30m resolution
- Globally consistent and locally relevant
- Possible with open archives and cloud computing
Multi-temporal image compositing

- Ability to specify area of interest instead of image footprint constraint
- Compositing algorithms advancing
- Results can be noisy

Landsat 8 2013  UMD ~2012 image
Surface reflectance

- At sensor radiance recorded but surface reflectance is more useful
- Significant progress but hasn’t trickled down to users
- Still waiting for global high resolution product
Biomass mapping

- Above-ground forest biomass important for REDD+ activities
- 1km and 500m pan-tropical products recently released
- A lot of money going toward developing and promoting methods

Frequency distribution of carbon  Baccini et. al. 2012 Nature
Land cover change over time

- An age old issue but methods still being improved
- High resolution change products becoming more accessible
- Accuracy hasn’t changed much over the years but it takes less time
- Using data from multiple sensors is having the greatest impact
New satellite sensors

- Increase in satellite-based active sensors
- Influence from ecology needs seems to be increasing
- High hopes for new hyperspectral sensor
Portable aerial platforms

- Driven by decrease in size and costs for hardware
- Main focus is UAVs
- Significant input from DIY community
- Legal constraints significant
Where are the gaps?

- Lack of production products of essential biodiversity variables
- Software and data processing work-flows to implement published methods are lacking
- Satellite and aerial platforms and sensors often designed for research not broad applications
- Need additional sensor data products: high resolution soil moisture, satellite-based vegetation structure
- Finding and accessing appropriate data is cumbersome
Improving the bridge
RS community helping ecological research

- Improve ability to find data (low and high level products)
- Publish work flows to derive useful metrics
- Develop production products for essential biodiversity variables
- Better understand what ecologist want/need
Improving the bridge
Ecology community helping RS research

- Collection of ground data (deliberate approach typically better than opportunistic)
- Validate products
- Feedback on utility of existing products
- Feedback for new products
Recent progress

- Remote sensing for ecology and conservation book organized by biome
- CRSNet working group
- University of Maryland global forest change map
- Remote sensing – biodiversity conservation web site: http://remote-sensing-conservation.org/
- New satellite programs (nano- and microsatellites, new sensors, open archives...
Working together to define needs and develop solutions

- Lobby for new sensors to address specific needs
- Join CRSNet and participate in working groups and discussions
- Improve ability for other people to build on your work
  - Use open licenses for documents, data, and software
  - Make guides, software, data and other products easily accessible