

Computer Science for Conserving Biodiversity

Steven Phillips
AT&T Labs-Research



Sustaining what, exactly?

- **Human quality of life**

- Consume less
- Make more efficient use of electricity, oil, ...
- Delay exhaustion of finite resources
- Consume less of resources with limited renewability
- Allow more people to drive, eat well, live in comfort (today, and in future)
- Avoid widespread disruption due to climate change

- **The rest of life on earth**

- Minimize the loss of species and ecosystems during this 6th great extinction
- Understand how natural systems ecosystems work
- Predict the effect of threats
 - Habitat destruction
 - Invasive species
 - Over-consumption / hunting
 - Climate change
- Design / optimize strategies to mitigate threats

The Role of Computer Science

- **Gathering and Processing information**

- Robotics, sensor networks
- Image understanding (whale tales, zebra stripes)
- Distributed databases (GBIF, HerpNET, MaNIS)
- Natural language processing (BioGeomancer)
- Visualization (Food webs, phylogeny, tree of life)

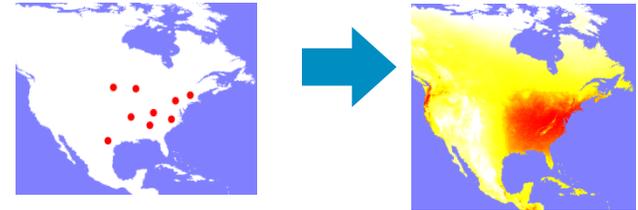
- **Modeling and understanding**

- Climate and climate change
- Species distributions
- Species dependence on environmental drivers
- Migrations
- ...

- **Planning and designing**

- Protected areas, marine parks, ...

Example research / applications



- **Species Distribution Modelling (SDM)**
 - Given: geographic records of species, environmental variables
 - Predict species presence/absence as a function of environment
 - Maxent: L1-regularized probability density estimation
 - Free software: >12,000 distinct user downloads, >1000 citations
- **Design and management of systems of protected areas**
 - Optimization software widely used (Great Barrier Reef, ...)
 - Multiple objectives, dynamism, stochasticity / uncertainty, non-linearities
 - Example: designing for climate change
 - Distribution of species' suitable conditions will change with climate
 - Plan protected areas to allow movement to future habitat
 - Plan for resilience: multiple pathways
 - **Like planning for fault-tolerance in a telecom network**
 - Network flow & integer programming:
 - *Dispersal corridors for Proteaceae*



SDM: ML research problems abound!

- Small sample sizes
- Biased samples
- Huge number of potential predictor variables
- Transferability
- Missing data, especially absences
- Complex interactions



Jaguar
(*Panthera onca*)



Javelina
(*Pecari tajacu*)



What's in it for corporate research?

- **Sustainability: more than just lip service**
 - Most large corporations have sustainability programs
 - Synergistic sustainability: aids bottom line, e.g. saving electricity
 - Support for conservation complements cost-savings programs
- **Public relations**
 - Science article on conservation planning in Madagascar
 - Video used for
 - TV commercial
 - AT&T Labs-Research recruiting web site
 - TED conference
 - Coolest-corporate-science competition supporting science education
 - **Energized researchers do useful basic research**
 - Maxent development involved basic ML research
 - Later used in commercial voice recognition technology (Vlingo)