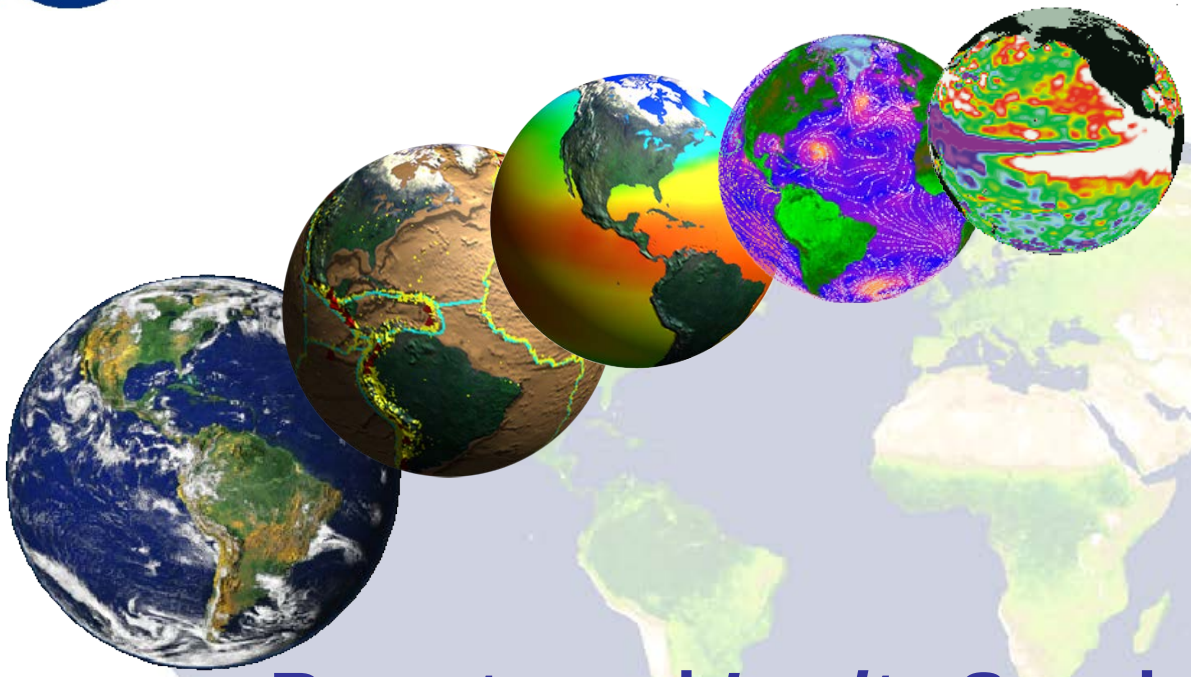
2014 World Parks Congress Stream 1:
Monitoring Conservation Outcomes Inside and Outside Protected Areas



Remote and *In situ* Sensing Networks:
Monitoring Protected Area Effectiveness through Integrated Biodiversity Observations and Modeling

Woody Turner
Earth Science Division
NASA Headquarters

November 17, 2014

The New York Times

es Square in Mumbai

Wary of Losing Rams, St. Louis Is Set to Huddle on Stadium

LETTER
Supporting New York City Parks

At a Bronx Park, Dreams of Greener Landscapes

The Opinion Pages | OP-ED CONTRIBUTORS

How to Mend the Conservation Divide

By EMMA MARRIS and GREG APLET OCT. 31, 2014

COMMENT

CONSERVATION Experts weigh in on priorities for the world's protected areas **p.28**

ECONOMICS Loss of natural and ecological capital leaves hole in national budgets **p.32**

CHEMISTRY The fame and shame of the elements that never were **p.34**

AUTOBIOGRAPHY Carl Djerassi, father of the Pill, reflects on his life and literature **p.36**

MIKE IANCETTA/GETTY

Conservation efforts risk getting snared in a tangle of aims.

A call for inclusive conservation

Heather Tallis, Jane Lubchenco and 238 co-signatories petition for an end to the infighting that is stalling progress in protecting the planet.

conservation organizations and even the media[6]. We believe that this situation is stifling productive discourse, inhibiting funding and halting progress.

Adding to the problem, in our view, is the issue that this dispute has become dominated by only a few voices, nearly all of them men's. We see this as illustrative of the bigger issues of gender and cultural bias that also continue to hinder conservation.

The stakes? The future of conservation science, practice and policy. Conservation regularly encounters varied points of view and a range of values in the real world. To address and engage these views and values, we call for more-inclusive representation of scientists and practitioners in the charting of our field's future, and for a more-inclusive approach to conservation.

EMBRACE DIVERSE VALUES AND VOICES

Women historically have been underrepresented in environmental-science faculty positions and in conservation practice, as in most scientific fields. This disparity is changing globally, but at different rates: more slowly in Asia and more quickly in Latin America and the Caribbean, for example[7]. In the United States, more than half the leadership positions in conservation organizations are now held by women. And on the global stage, women currently hold top positions in many leading efforts, including the Intergovernmental Platform on Biodiversity and Ecosystem Services, the Future Earth science committee, and the International Union for Conservation of Nature. This progress makes the dearth of female voices in the debate about the premise of our

(Nature 515:27-28, 11/6/14)

Calls to Bridge Divides Regarding the "How" and the "Why" of Conserving Nature in the Anthropocene

Premises

- We must monitor.
  - Monitor the status of biodiversity as a key metric for protected area effectiveness, a la Stephen Palumbi et al. 2009 in *Front Ecol Environ* who argued for conserving biodiversity as a means of maintaining ecosystem services
- We have tools.
  - Focus for much of these sessions
- We need a plan.
  - Input for the Promise of Sydney: call for the development of an integrated global plan for monitoring the status and trends of biodiversity within PAs to measure PA effectiveness

We Have Tools:
Satellite Remote Sensing

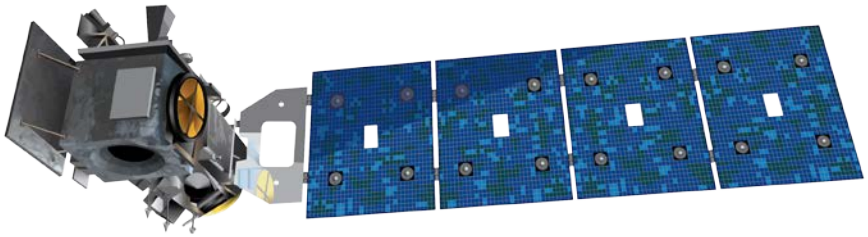
We Have Tools: Airborne Remote Sensing

From Spectral Diversity to Biochemical Diversity to Taxonomic Diversity

3-D forest canopy and chemistry in the Peru-Brazil Amazon region (Carnegie Airborne Observatory)
(from Carnegie Airborne Observatory Image Gallery at http://cao.ciw.edu/?page=images)

Back to Satellites: Capturing Ecosystem Composition, Function, and Structure *Globally* from Space

HyspIRI: VSWIR Spectrometer and Multispectral TIR Imager



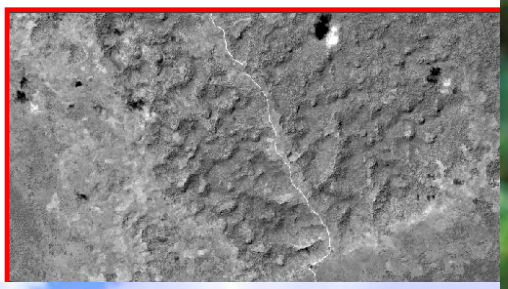
ICESat-2: Atlas Lidar

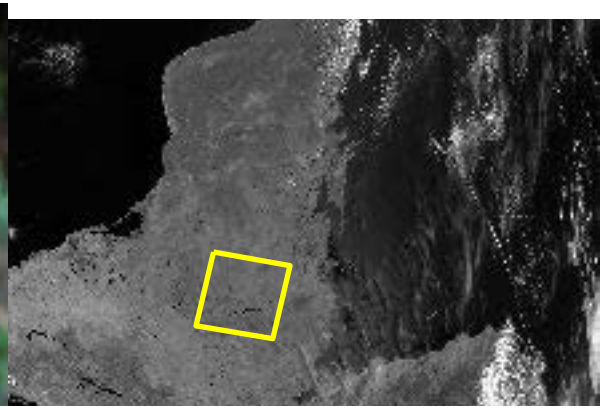
What's Next? Ubiquitous Smallsats

First of Planet Labs Flock Leaves ISS on 11 February 2014

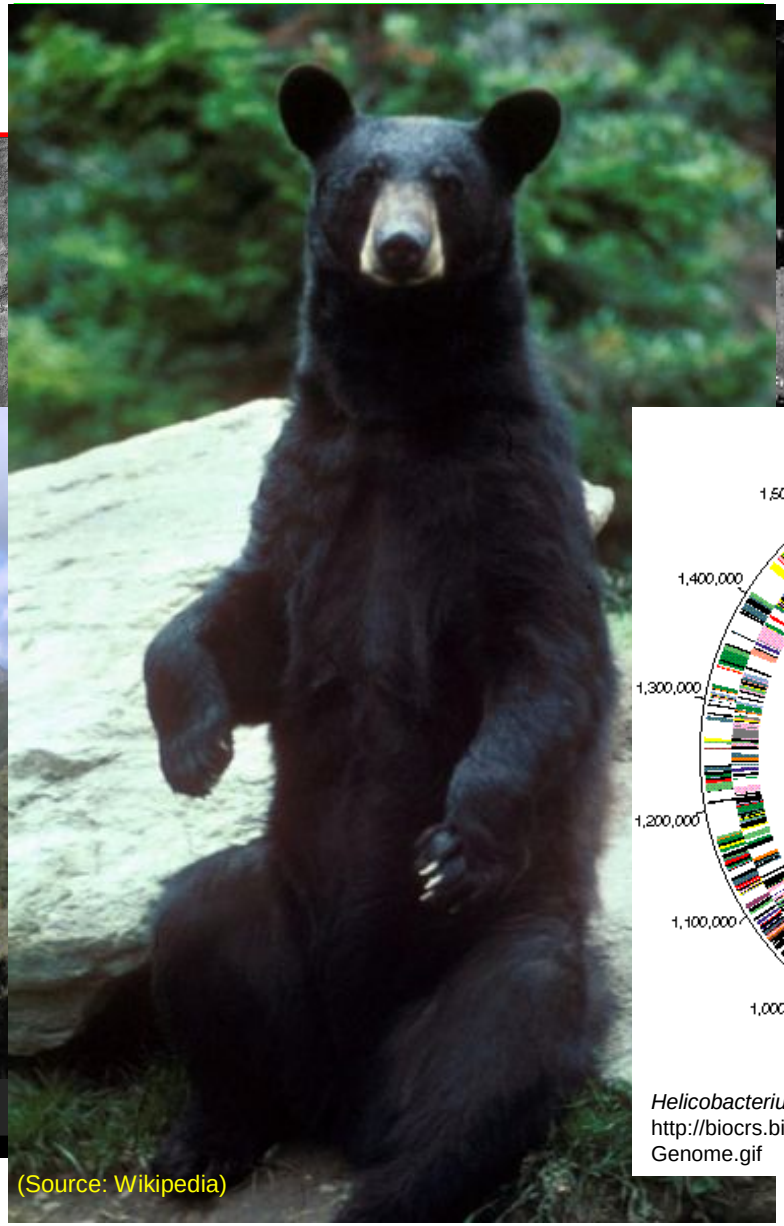
(photo by JAXA astronaut Koichi Wakata)

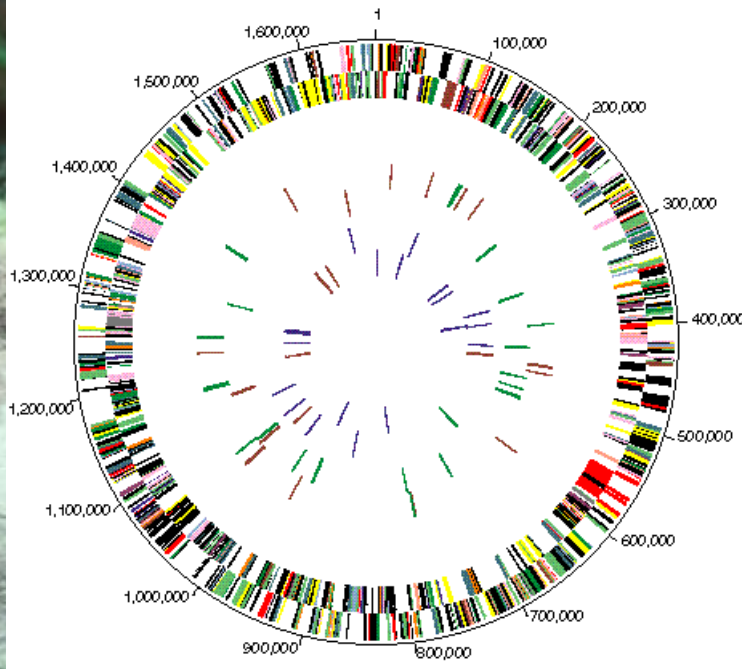
The Challenge of Scale: Seeing Finer and Finer Patterns





(Zoom-in courtesy:
MSFC/Dan Irwin)





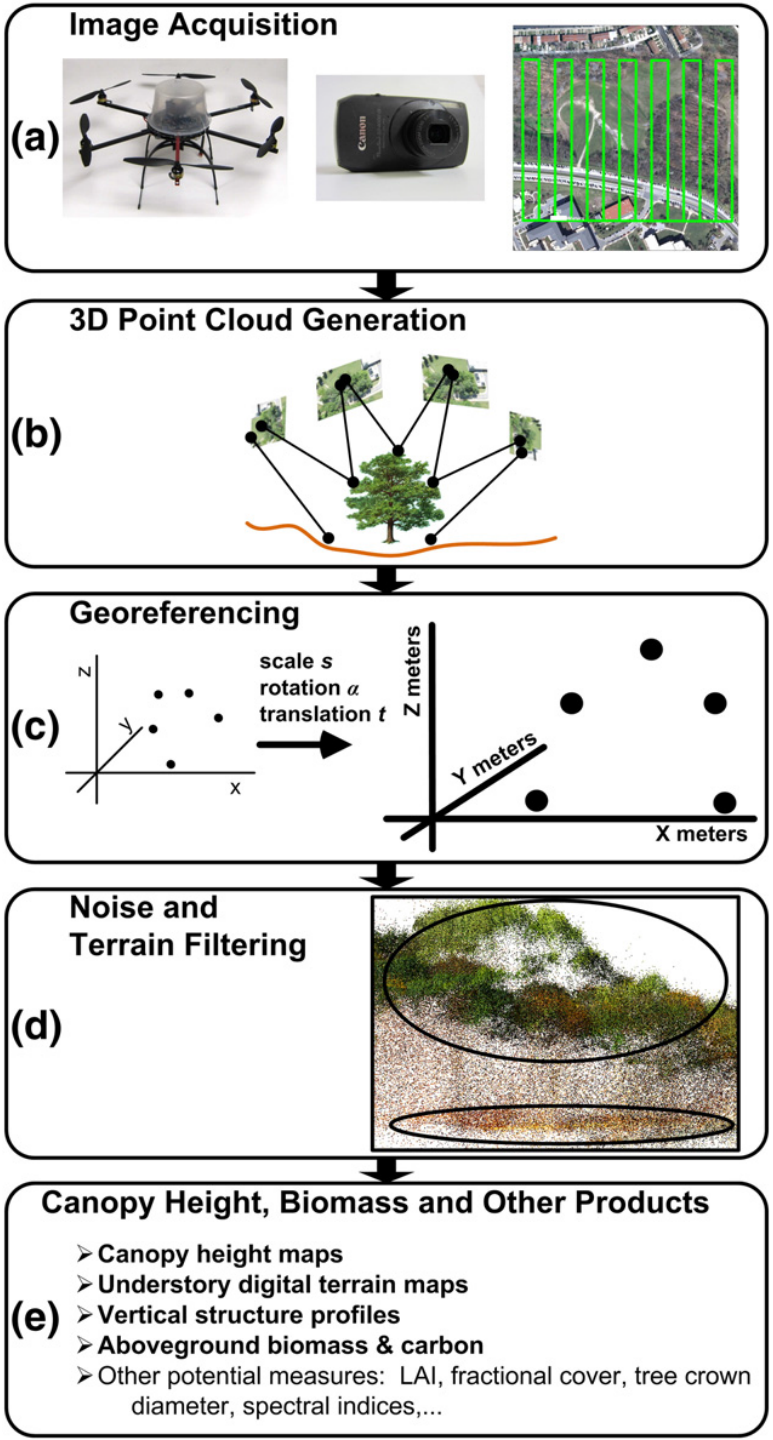
Helicobacterium pylorii Genome from:
http://biocrs.biomed.brown.edu/Books/Chapters/Ch%2038/Pylori-Genome.gif

We Have Tools: *In Situ* Mapping Vegetation in 3D

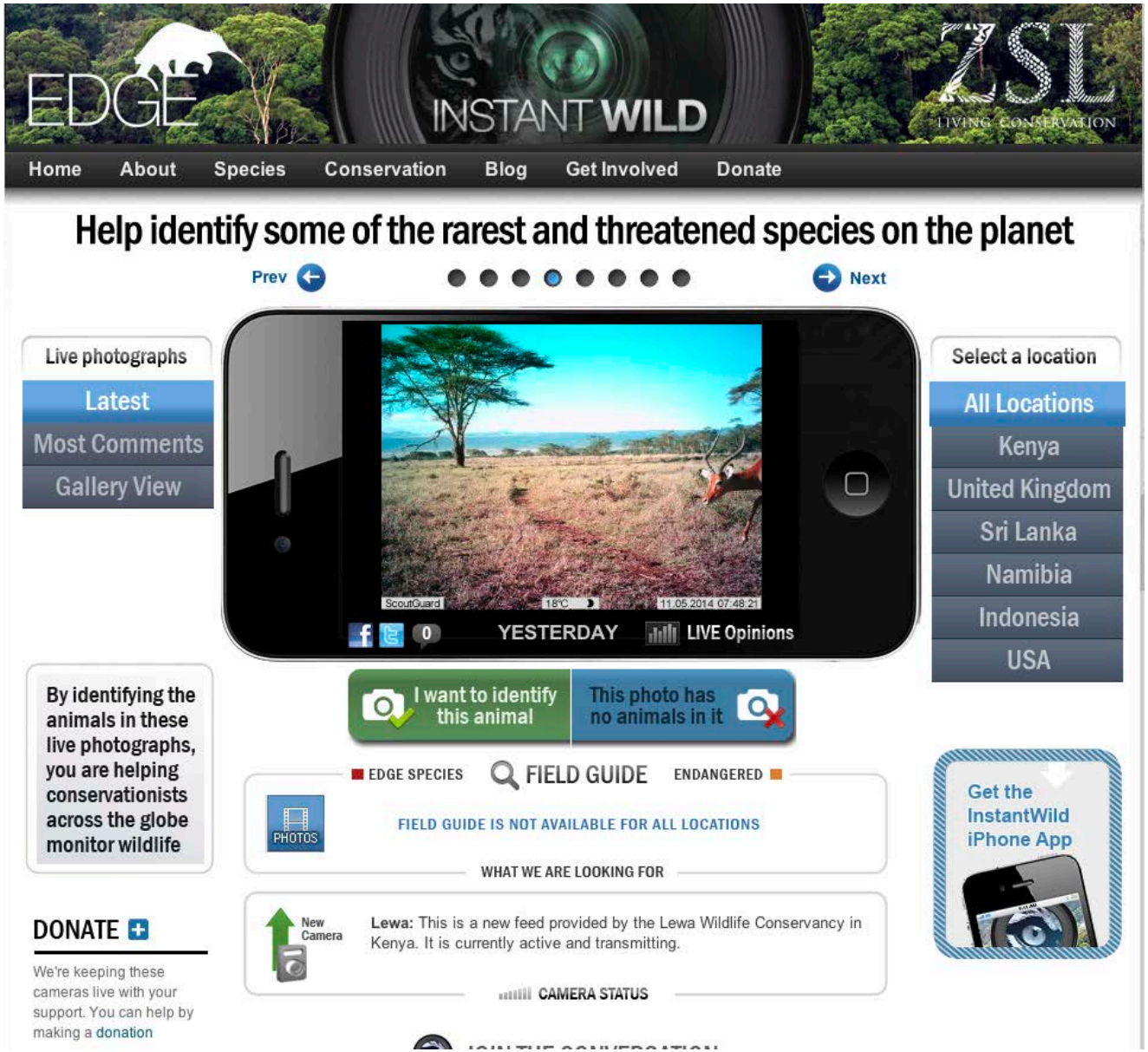
- Dandois and Ellis used **<$4000 hexakopters** with **off-the-shelf digital RGB cameras** and **Ecosynth "Structure from Motion" computer vision algorithms** to take sets of overlapping low altitude (<130m) photos and **create 3D point clouds** of 30-67 points m^{-2} to generate understory digital terrain models (DTMs) and canopy height models (CHMs) in MD forests
- CHMs highly correlated with a lidar CHM acquired 4 days earlier; biomass and carbon densities less well correlated
- Changes in canopy relative greenness were highly correlated (R^2=0.87) with MODIS NDVI
- Ecosynth time series measures captured vegetation structural and spectral phenological dynamics at the individual tree scale with the same sensor
- New era of participatory remote sensing?

High spatial resolution three-dimensional mapping of vegetation spectral dynamics using computer vision ***RSE* 136:259-276 (2013)**

Jonathan P. Dandois and Erle C. Ellis/UMBC



Camera Traps



From Light to the Power of Sound

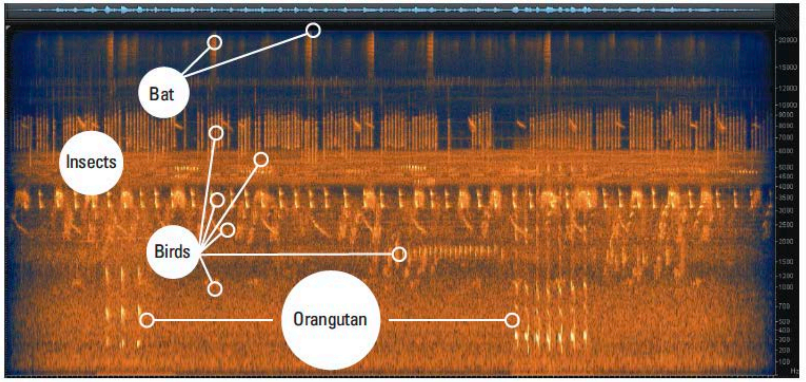
- Field of Soundscape Ecology leveraging cheap, rugged automated recorders and sound analysis software
- Analogues to light remote sensing abound; now in a sonic index-generation phase
- Soundscapes converted into color-coded spectrograms for visualization by Michael Towsey of Queensland University of Technology; changes over the course of a day (= “acoustic weather”) or over seasons to years (= “acoustic climate”); potential is there to track acoustic climate change though biology
- Pijanowski and team compared soundscapes with lidar data in Costa Rica; hot spots for vocal species correlate with large gaps in upper forest canopy and dense foliage in lower canopy
- A Big Data challenge” “terabytes of sound”

(soundscape ecologist Purdue/Bryan Pijanowksi on a research tower in Borneo)

Eavesdropping on Ecosystems

Researchers are collecting terabytes of recordings, from bird chirps to chainsaw roars. The emerging field of soundscape ecology has a lot to offer … and a lot to prove

(Kelly Servick, 2014, *Science* 343:834-837)



Everything in its place. A recording from the Sumatran rainforest illustrates the acoustic niche hypothesis, in which different kinds of animals utilize different parts of the sound spectrum. Bats, for instance, call at higher frequencies while orangutans use lower frequency sound.

Environmental DNA (eDNA)

US Army Corps of Engineers
Chicago District

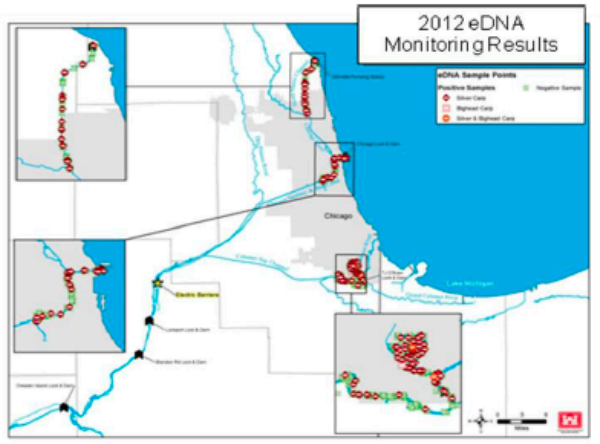
Asian Carp Monitoring Fact Sheet
eDNA Surveillance and Calibration

Chicago Sanitary and Ship Canal – Aquatic Nuisance Species Dispersal Barrier

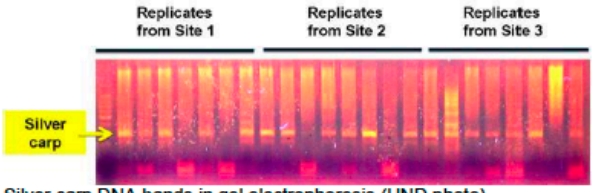
Overview:
One of the tools implemented by the Asian Carp Regional Coordinating Committee's (ACRCC) Monitoring and Rapid Response Work Group (MRRWG) to conduct monitoring of Asian carp in the Chicago Area Waterways System (CAWS) is Environmental DNA (eDNA) surveillance. eDNA is a genetic tool that indicates the presence or absence of species-specific DNA in the aquatic environment. Fishes, including Asian carp, release cells containing DNA into the environment from mucus, feces and urine. DNA degrades in the environment, but this process is not instantaneous, and DNA can be held in suspension and transported. Species can be detected by filtering water samples and then extracting and amplifying short fragments of the shed DNA. The MRRWG has used eDNA as an early detection monitoring tool in the Chicago Area Waterway System (CAWS) since 2010, led by USACE. In 2013, eDNA monitoring will be led by the U.S. Fish and Wildlife Service.

A positive eDNA detection indicates the presence of Asian carp DNA. At present, eDNA evidence cannot verify whether the DNA is from a live fish, nor does it provide information about Asian carp quantity, age, size, how they got there or how long they may have been there.

Methods:
The *Quality Assurance Project Plan (QAPP) for the eDNA Monitoring of Invasive Asian Carp in the CAWS* outlines the detailed procedures for the planning, collection, filtering, processing and reporting of eDNA samples and is available online:www.asiancarp.us/documents/USACE-eDNA-QAPP.pdf

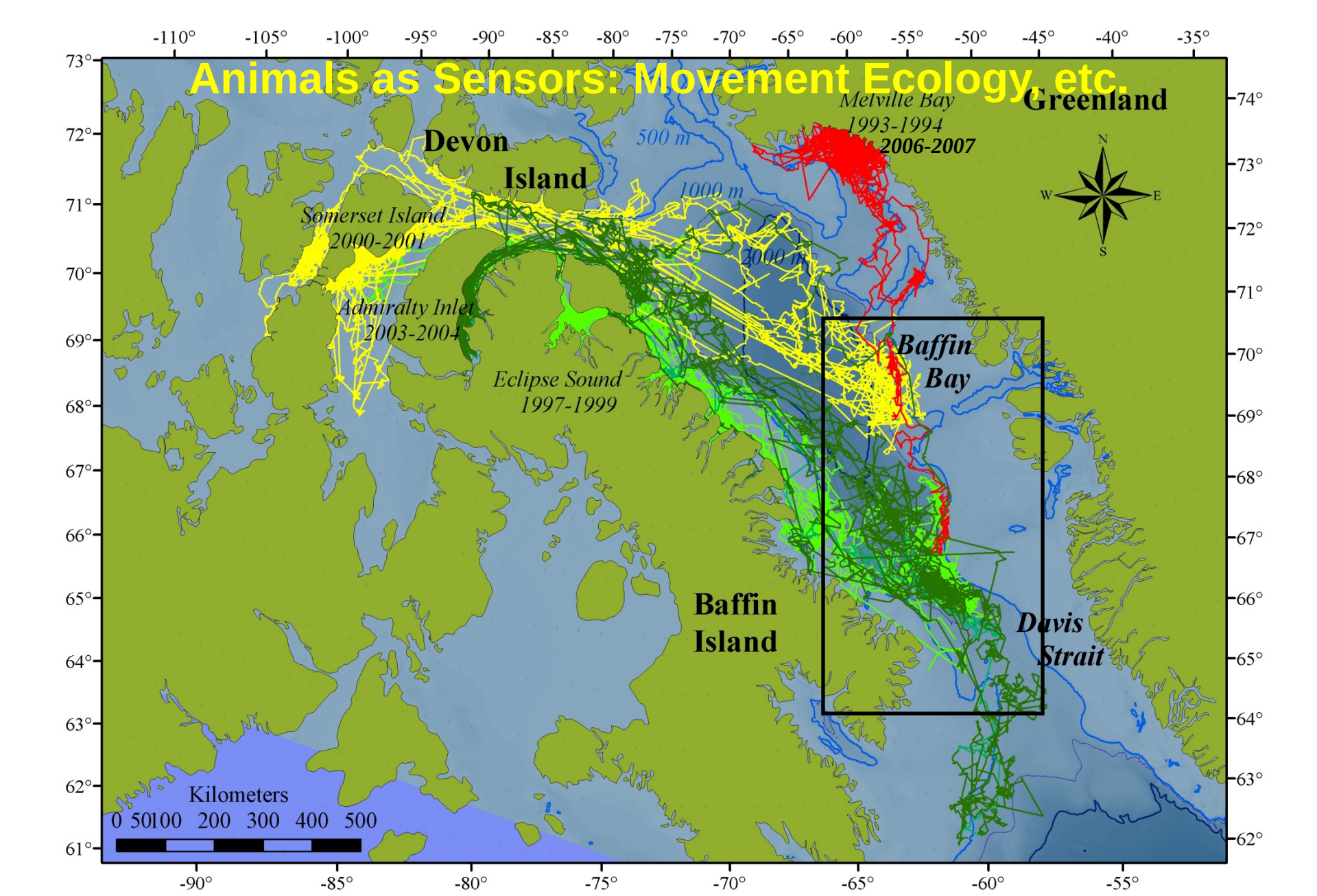


Map of 2012 eDNA results



Silver carp DNA bands in gel electrophoresis (UND photo)

What's Next?
USACE is leading an interagency eDNA Calibration Study (ECALS) with USGS and USFWS to reduce the uncertainty surrounding eDNA results and refine the eDNA method.



Dietz et al. (2008), Heide-Jørgensen et al. (2003), Laidre et al. (2005) (slide: UWA/Kristin Laidre 2011)

Citizen Science

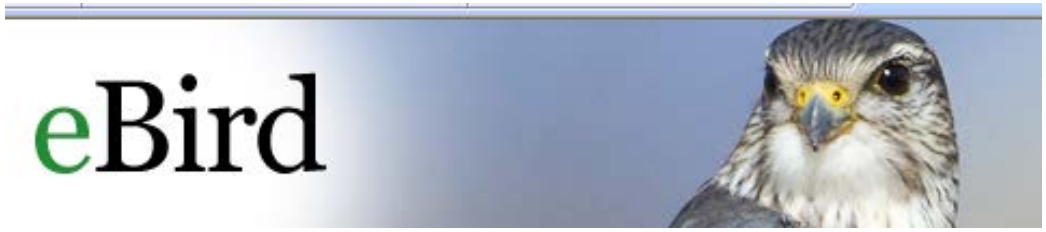
ATLAS OF LIVING AUSTRALIA
sharing biodiversity knowledge

USA npn
National Phenology Network
Taking the Pulse of Our Planet

Audubon
Christmas Bird Count

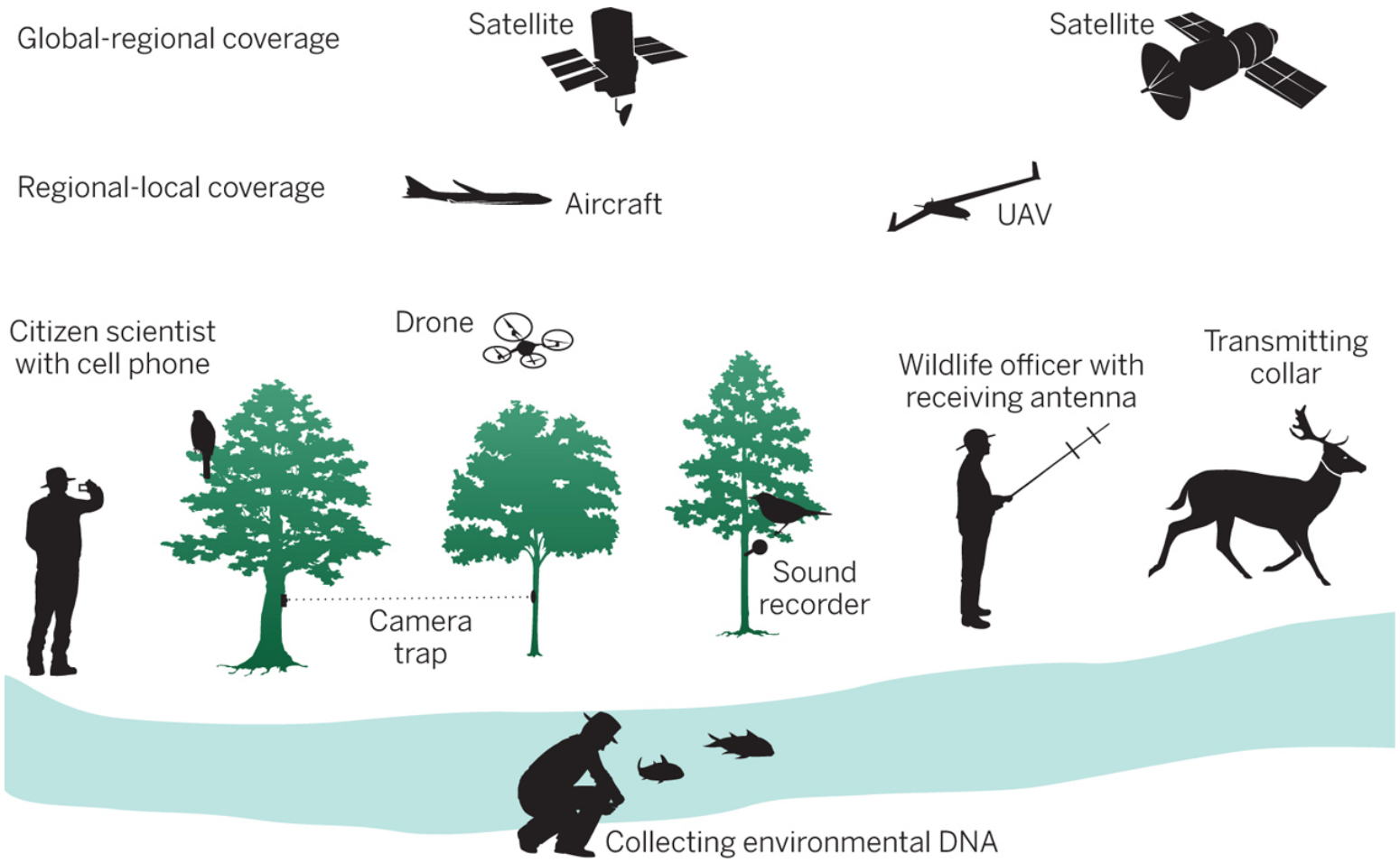
Project FeederWatch
Embrace the winter. Count feeder birds for science!
The Cornell Lab of Ornithology
Bird Studies Canada / Études d'oiseaux Canada

iNaturalist.org



eol
Encyclopedia of Life

Challenge = Networking Observations (and Models)



(*Science* 346:301-302, 10/17/14)

Group on Earth Observations (GEO)
A Global Framework for Integration

GEO Biodiversity Observation Network (GEO BON)

GROUP ON EARTH OBSERVATIONS | GEO BON

GEO Home

Biodiversity Community of Practice

GEO BON: Biodiversity Observation Network

- About
- Contributors
- Working Groups
- Meetings
- Essential Biodiversity Variables
- Documents
- Outreach
- Observations
- Links
- Contact

Highlights

Adequacy of Biodiversity Observation Systems

In response to a decision taken last November at the Nagoya conference of the Convention on Biological Diversity, GEO BON has produced and submitted to the CBD a report entitled "Adequacy of Biodiversity Observation Systems to support the CBD 2020 Targets". The report can be read here.

EC JRC launches DOPA, a Digital Observatory for Protected Areas

The Joint Research Centre of the European Commission has launched the Digital Observatory for Protected Areas (DOPA). A GEO BON contribution to the monitoring of biodiversity, the DOPA is designed as set of distributed web services to assess the state of, and pressure on, Protected Areas and to prioritize them accordingly in order to support decision making and fund allocation processes. It is also conceived as a monitoring and ecological forecasting service.

DOPA is supported by the European projects EuroGEOSS and UncertWEB and developed in collaboration with GBIF, UNEP-WCMC, Birdlife International, RSPB and others. Read here a description of the use of DOPA for Africa presented at MapAfrica, 23-25 November 2010, Cape Town, South Africa.

GEO BON

Biodiversity Observation Network

The Group on Earth Observations Biodiversity Observation Network – GEO BON – coordinates activities relating to the Societal Benefit Area (SBA) on Biodiversity of the Global Earth Observation System of Syster (GEOSS). Some 100 governmental, inter-governmental and non-governmental organizations are collaborating through GEO BON to organize and improve terrestrial, freshwater and marine biodiversity observatio globally and make their biodiversity data, information and forecasts more readily accessible to policymakers, managers, experts and other users. Moreover, GEO BON has been recognized by the Parties to t Convention on Biological Diversity.

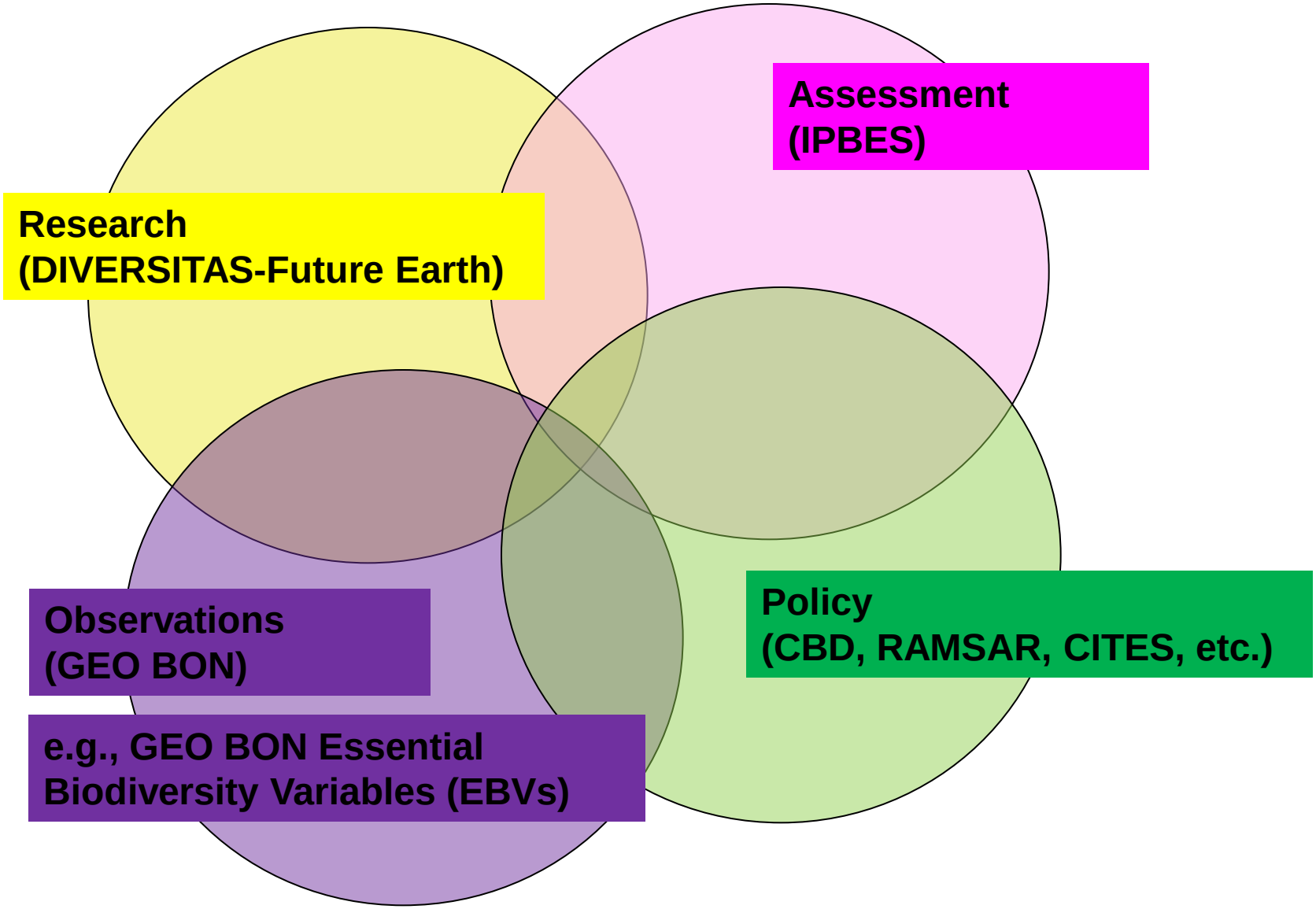
The Biodiversity Observation Network is both a Community of Practice and a Task in the GEO Work Plan. It is a voluntary partnership that is guided by a steering committee comprising the key stakeholders, includi DIVERSITAS, GBIF, IUCN, NASA, UNEP-WCMC and others. GEO BON draws on GEO's work on data-sharing principles to promote full and open exchange of data, and on the GEOSS Common Infrastructure to enab interoperability through adoption of consistent standards.

To assist both holders and users of biodiversity information to engage with GEO BON, this website contains links to information resources, activities and GEO BON documents, meetings and other resources.

Example Essential Biodiversity Variables Candidates

EBV Class	EBV Examples
Genetic composition	Population genetic differentiation
Species populations	Species distribution
	Population abundance
Species traits	Phenology
Community composition	Taxonomic diversity
Ecosystem function	Productivity
	Nutrient retention
Ecosystem structure	Habitat structure
	Extent and fragmentation
	Ecosystem composition by functional type

Global Biodiversity Science-Policy Network



(slide courtesy of DIVERSITAS/Anne Larigauderie)

For The Promise of Sydney

We need an integrated global plan to network observations and models on the status and trends of biodiversity within and around protected areas as a means of measuring the effectiveness of protected areas.

Thank You