The GEO Biodiversity Observation Network (GEO BON)

Biodiversity & Ecosystem Informatics (BioEco) Working Group Meeting

May 14, 2009

NASA Headquarters

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Earth Science Division
NASA Headquarters

(Slides Courtesy of JPL/Gary Geller)

Overview

- What is GEO?
- Why is GEO BON needed?
- What will GEO BON do?
- Implementation and challenges
- Status and Next Steps

Sagra buqueti edof

What is GEO BON?

- Global network of networks of…
  - Interoperating observation systems relevant to biodiversity
- Collect, manage, analyze, share data on biodiversity's status & trends

POLICYFORUM

ECOLOGY

Toward a Global Biodiversity Observing System

Tracking biodiversity change is increasingly important in sustaining ecosystems and ultimately human well-being.

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Biodiversity is a composite term used to embrace the variety of types, forms, spatial arrangements, processes, and interactions of biological systems at all scales and levels of organization, from genes to species and ecosystems (*1*), along with the evolutionary history that led to their existence (*2*). In part because of this complexity, universally applicable measures of biodiversity have proven elusive. Commonly used measures, such as the number of species present, are strongly scale-dependent and only reveal a change after species have been lost. Indices incorporating several proxy signals are potentially sensitive, but their arbitrariness obscures underlying trends and mechanisms. Integrated measures (*3*, *4*) are both sensitive and achievable, but more research is needed to construct the globally robust relations between population data, genetic variation, and ecosystem condition that they require.

The need for national to global-scale biodiversity measurements has been highlighted by the adoption of a target to "reduce the rate of loss of biodiversity by 2010" by the 190 countries that are parties to the Convention on Biological Diversity (CBD) (*5*, *6*). As we approach the target date, it is clear that this intention may suffer if we cannot effectively assess progress. The recent Conference of Parties to the CBD in Bonn, Germany, reinforced commitment to the goal, while acknowledging that much still needs to be done to reach it. Despite the absence of comprehensive data, there is little dispute that biodiversity continues to decline with uncertain, but potentially serious, consequences for society (*7*).

Unlike, for instance, the Framework Convention on Climate Change, there is no widely accepted and globally available set of measures to assess biodiversity. Consequently, the community has fallen back on a range of existing data sets gathered for other purposes. Currently, in the CBD process alone, there are ~40 measures reflecting 22 headline indicators in seven focal areas (see Biodiversity Indicator Partnership, www.twentyten.net). It seems unlikely that this set will provide clear messages to decision-makers (*8*).

There is no general shortage of biodiversity data, although it is uneven in its spatial, temporal, and topical coverage. The problem lies in the diversity of the data and the fact that it is physically dispersed and unorganized (*9*). The solution is to organize the information, to unblock the delivery pipeline between suppliers and users, and to create systems whereby data of different kinds, from many sources, can be combined. This will improve our understanding of biodiversity and will allow the development of fit-for-purpose measures of its condition over time. The proposed Group on Earth Observations Biodiversity Observation Network (GEO BON) is a new global partnership to help collect, manage, analyze, and report data relating to the status of the world's biodiversity.

The Group on Earth Observations (GEO) was launched in 2002 in response to the widely identified need for adequate information to support environmental decision-making. GEO is a voluntary partnership of 73 national governments and 46 participating organizations. It provides a framework within which these partners can coordinate their strategies and investments for Earth observation. The GEO members are establishing a Global Earth Observation System of Systems (GEOSS, www.earthobservations.org) that provides access to data, services, analytical tools, and modeling capabilities through a Web-based GEO Portal (www.geoportal.org). GEOSS has identified nine priority "societal benefit areas" in its first decade. Biodiversity is one of them. U.S. National Aeronautics and Space Administration (NASA) and DIVERSITAS, the international programme of biodiversity science, accepted the task of leading the planning phase of GEO BON, in collaboration with the GEO Secretariat.

No single organization could build a "system of systems" such as the one envisaged. Many local, national, and international activities exist to record various genes, species, and ecosystems, as well as the services they provide to society. GEO BON aims to create a global network from these efforts by linking and supporting them within a scientifically robust framework. For example, GEO BON will facilitate the combination of top-down measures of ecosystem integrity from satellite observations with a host of bottom-up measures of ecosystem processes, population trends of key organisms, and the genetic basis of biodiversity arising from the latest field-based and molecular survey methods. The role of GEO BON is to guide data collection, standardization, and information exchange. The participating organizations retain their mandates and data ownership, but agree to collaborate in making part of their information accessible to others.

The process to develop a GEO BON took shape in April 2008, when some 100 biodiver-

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Scholes et al., Science 321: 22 August 2008, Toward a Global Biodiversity Observing System

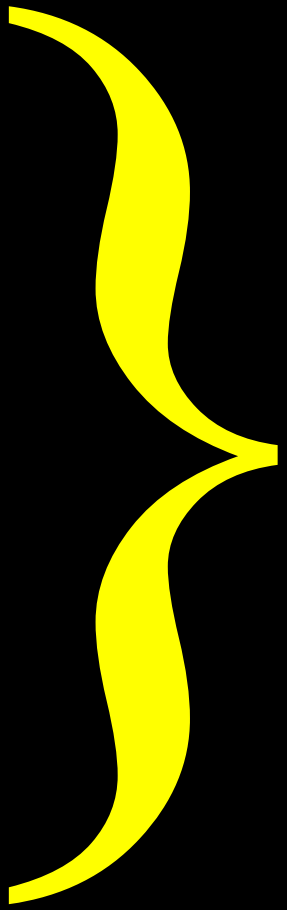
Group on Earth Observations

- Response to 2002 World Summit on Sustainable Development & G8
- Global collaboration needed
- Enhance interoperability of observing systems
- Voluntary partnership
  - 77 governments & EC
  - 56 participating organizations

Chiasognathus granti

GEOSS

- GEO is building Global Earth Observation System of Systems
  - Disasters
  - Health
  - Energy
  - Climate
  - Water
  - Weather
  - Agriculture
  - Ecosystems
  - Biodiversity



9 SBAs

GEO BON

Why do we need GEO BON?

Fundamental Argument:

- We live in the "Anthropocene"
- In effect, we are managing the planet for our own ends
- We have a species survival imperative to act wisely to maintain the components of the Earth system upon which we depend
- Biodiversity is a key--& threatened--component of this system
- We know relatively little about it, a la Lord Robert May
- There are many discrete efforts to observe & understand it
- There are also important gaps
- Greater coordination & integration of observations would help
- A scientifically-based network is key for intelligent management with conservation
- Climate science shows a way forward? An EOS for biodiversity?

Why do we need GEO BON?

- Lots of observations
  - But diverse, dispersed, disjointed
  - In space, time, content, format, quality
- Lack of interoperability
- Need to bring biological & geophysical Earth science data into a common framework
- Much more data collected than used
- Delivery pipeline to users blocked, at times
- Support for global assessments

Lack of integration

Why do we need GEO BON?

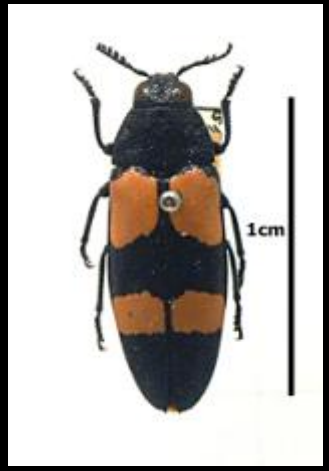
- Many gaps in observations
  - Spatial
  - Temporal
  - Taxonomic
  - Topical
- Uneven coverage

Oxynodera distincta

Lack of integration

History

- October 2006: first meeting
- March 2008: Draft Concept Document
- April 2008: stakeholder meeting
  - Support for basic concept
  - Formed implementation WGs
- September 2008: Concept Document
- October 2008: Implementation Overview Document
- November 2008: GEO V Plenary
- January 2009: Steering Committee formed

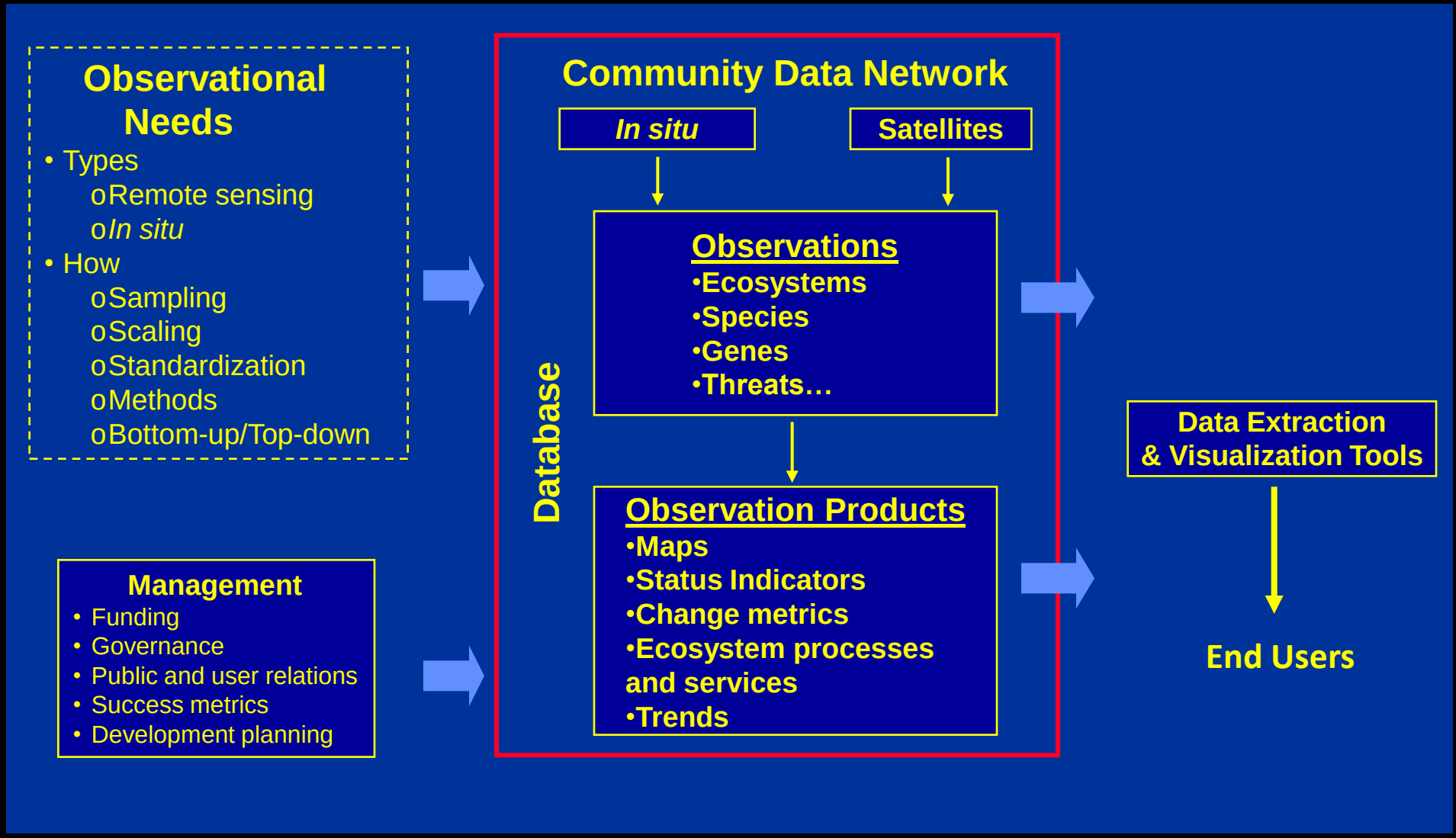


Agelia petelii nigrita

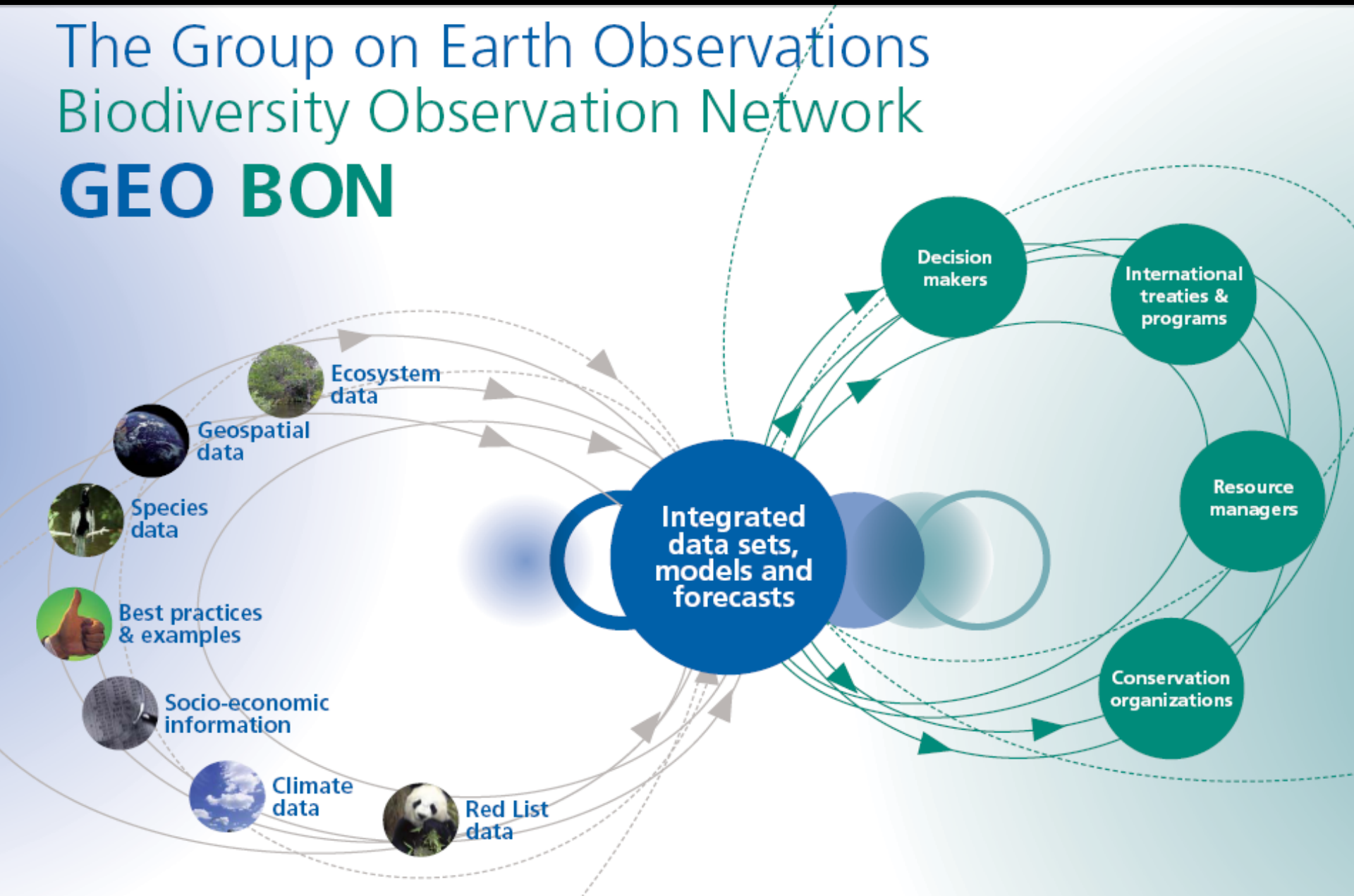
Concept

Scarabaeus pius

Concept overview



Integration



Target Users

- National governments and agencies
- Parties to international conventions
- Conservation organizations
- Decision makers
- Researchers
- Public

Megistomela punctatissima

Goals

- ❑ Create system of systems
- ❑ Establish global framework

- ❑ Assess current state of biodiversity
- ❑ Monitor change over time
- ❑ Quantify and map the *causes* of change
- ❑ Record the *impacts* of change
- ❑ Provide ecological forecasts

Doryphora pyrrhoptera

What value does GEO BON add?

- ❑ Coordinated data acquisition
- ❑ Global system (of systems)
- ❑ Improved information delivery using toolsets
- ❑ New "value-added" analytical products (e.g.,)
  - Global maps of ecosystem services
  - Predicted areas of rapid degradation
  - Key sites facing rapid climate change

Gymnopleurus nitens

Additional characteristics

- Focused on change
- Works at multiple scales
  - Ecosystems, species, genes
- Framework for interaction, coordination, integration
- End-end continuity

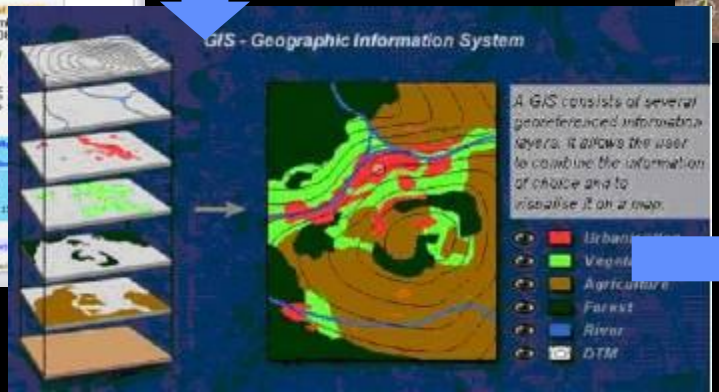
Pseudomesomphalia decemguttata

End-end continuity

From raw physical data

To electronic data

To data processing



To information generation

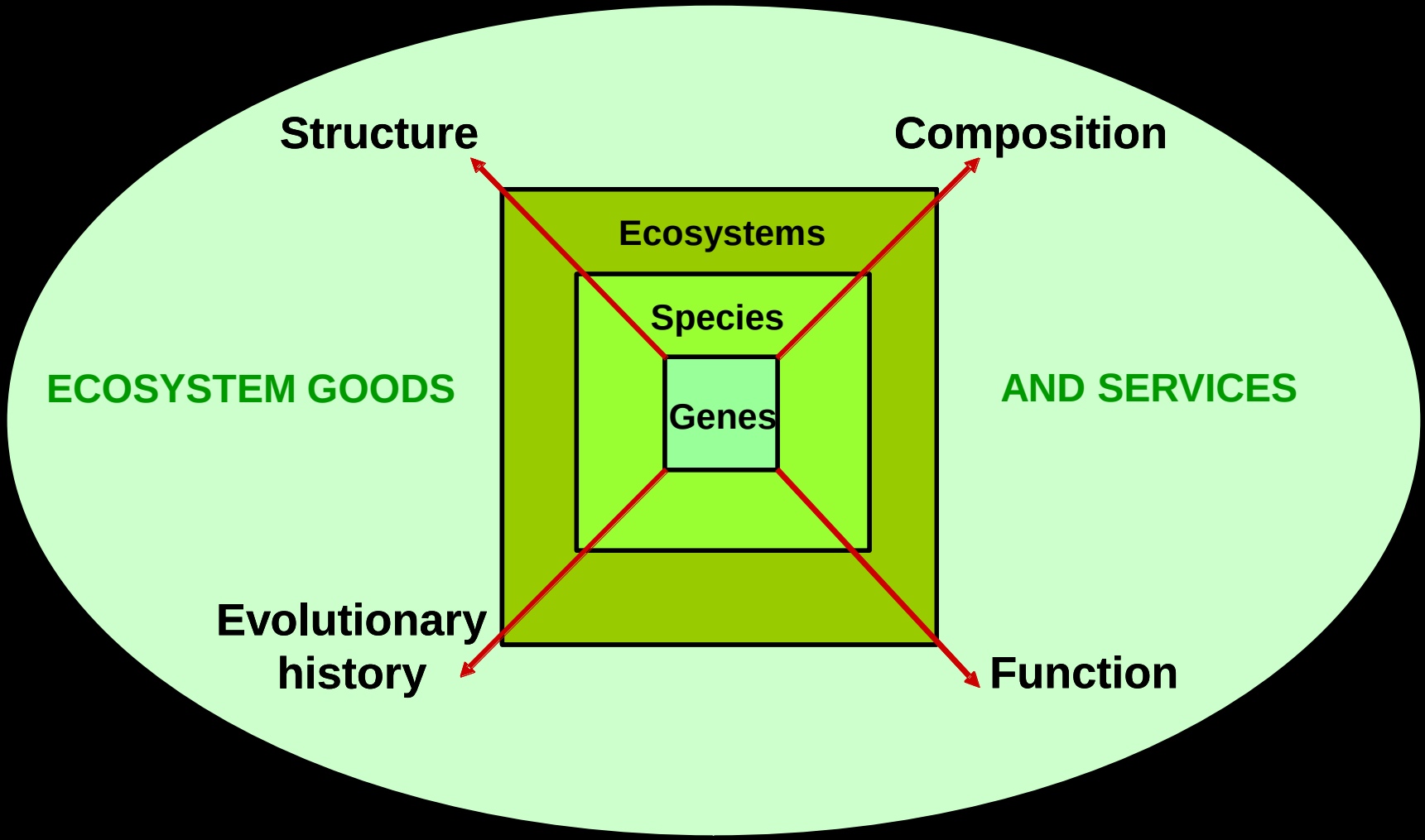
To knowledge and decision making

Observations:

Ecosystems, species, genes, and ecosystem services

Doryphora undata

Observations



(Courtesy R. Scholes 2008 by way of R. Noss)

Ecosystems

- Global maps

- Terrestrial
- Freshwater
- Marine

- Distribution
- Extent
- Condition

Chrysochroa.buqueti

Ecosystems: Change

- What
- How
- Causes
- Consequences

Prosicela vittata

Ecosystems

- GEOSS Global Ecosystem Mapping Task

Ecosystems: Terrestrial datasets

	Category	Dataset	Priority	Data providers
Terrestrial	Status and distribution	Coarse Ecosystem map	Short-term	GEO EC06.02 (baseline+ 1st iter.)
		Ecosystem condition and composition	Medium-term	ILTER, BIOTA, MAB Biosphere Reserves
		Fine Ecosystem map (e.g., forest plantation map)	Long-term	GEO Land-Cover, FAO, Government Agencies, CBD
	Drivers	Land use change map (conversion to agriculture, afforestation, logging, fragmentation, urbanization)	Short-term	GEO Global Forest Task. FAO, Government Agencies, GTOS (GOFC-GOLD)
		Farmland intensification	Short-term	GEO Agriculture, GEO Ecosystems, FAO, Government Agencies
		Climate change	Short-term	GEO Climate
		Desertification	Long-term	GEO, FAO, Government Agencies, Dryland Convention
		Human Encroachment (noise, night-lighting, soil disturbance, litter, roadkill, domesticated animals, hunting, etc.)		
		Pollution (pesticides, industrial waste, radioactive material, sewage, etc.)		
		Urbanization		
	Ecosystem services	Carbon sequestration	Short-term	GEO, Universities. Global Carbon Project
		Fire regime	Short-term	GEO Disasters, Government Agencies, European Environment Agency, Universities, NGOs
		Water cycle regulation	Long-term	GEO, GCOS
		Timber provisioning and other forest products	Short-term	FAO, Government Agencies, GEO
		Crop production	Short-term	FAO, Government Agencies, GEO

Species

- Address basic questions
  - How is distribution changing?
  - How is abundance changing?
- Utilize representative species

- Develop coordinated *in situ* sampling scheme
- Combine with models
- Sample at intervals

- Fills in gaps
- Requires capacity building

Species: methods

- In-situ sampling
- Modeling
- Remote sensing

- Vary by ecosystem
- Vary by taxa (e.g., micro-organisms)

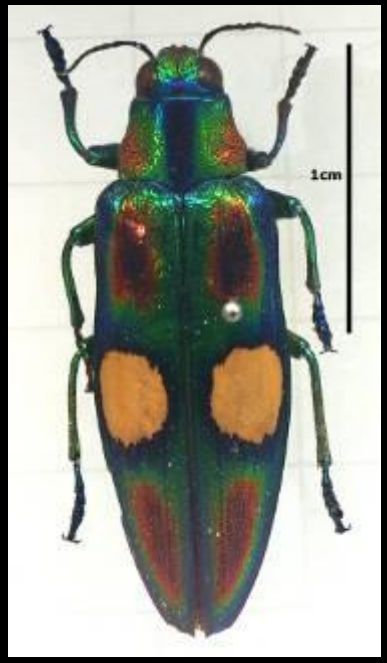
Species: Which ones?

Stratum	Included groups
Provisioning species	Domesticated mammals & birds, food crops, forestry species, medicinal plants, wild-harvested mammals, freshwater fish, coastal reef fishes, marine high tropic fish, pelagic fish, demersal fish
Treaty species: Migratory, RAMSAR, CBD, etc.	Migratory passerines, migratory waterfowl, sedentary waterfowl, large marine mammals, sea turtles
Key functional groups	Pollinators, N-fixing organisms, soil nematodes, keystone food plants
Top predators	Sharks, raptors, mammalian predators, snakes, spiders
Herbivores	Bovids, caprids, camelids, antelopes, rabbits, hares (e.g., for mammals)
Primary producers	Grasses, trees, shrubs, mosses, corals, phytoplankton, seagrass
Detritivores	Crayfish, lobsters, crabs, dung beetles, earthworms, molluscs, termites
Charismatic species	Elephant, rhino, hippo, primates, large cats, wolves, bears, pandas, whales, dolphins
Indicator groups	Salamanders and newts, rainforest frogs, freshwater frogs, butterflies, moths, bats, lichens, fruit-eating birds, ants, seed-eating birds, insect-eating birds
Disease and pest species	Human disease-vector insects, ticks, small rodents, locusts, crop pest insects, crop weeds, aquatic weed plants, toxic algal bloom species
Evolutionary clade representatives	Ferns, cycads, echinoderms, ascidians, crocodiles, tortoises
Major Ecosystem types	Freshwater, coastal, marine, forest & woodland, wetland, dryland

Genes

- Observe genes and variability over time
  - Selected species and genetic components
- Relate to species range and environment
- Relate to changes in environmental condition

- Important for…
  - Small population sizes
  - Large scale harvesting
  - Large scale release operations



Chrysochroa ocellata

Genes: Inference

- Genes are linked to larger characteristics
  - Species range
  - Physical environment
- Genes and diversity can be inferred
  - Modeling
  - Remote sensing

Leptinotarsa flavitarsus

Ecosystem goods and services

- Quantify change using indicators

- Goods
  - Food and fiber
- Services
  - Clean air and water
  - Waste disposal
  - Pollination

Cladognatha confucius

Ecosystem goods and services

State	Metric	Data providers
Goods		
Change in quality or quantity of goods (e.g., wood supply, fruit, vegetables, shellfish, sport hunting, fisheries, harvests)	Number, mass, diversity, quality and availability of products	Government and industry organisations
Services		
Change in availability of recreational space, water and/or air quality, environmental quality, waste disposal, local climate	Contaminant concentrations, availability of service, drought and flood events, pollination success rate, indicator species abundance and distribution	Environmental monitoring agencies (including meteorological, hydrological, pollution control)

How will GEO BON do all this?

- Community-based data format and content standards
- Interoperation of existing observation systems
- Fill in data gaps
  - Improved sampling
  - Improved modeling

None of this is easy!

Implementation

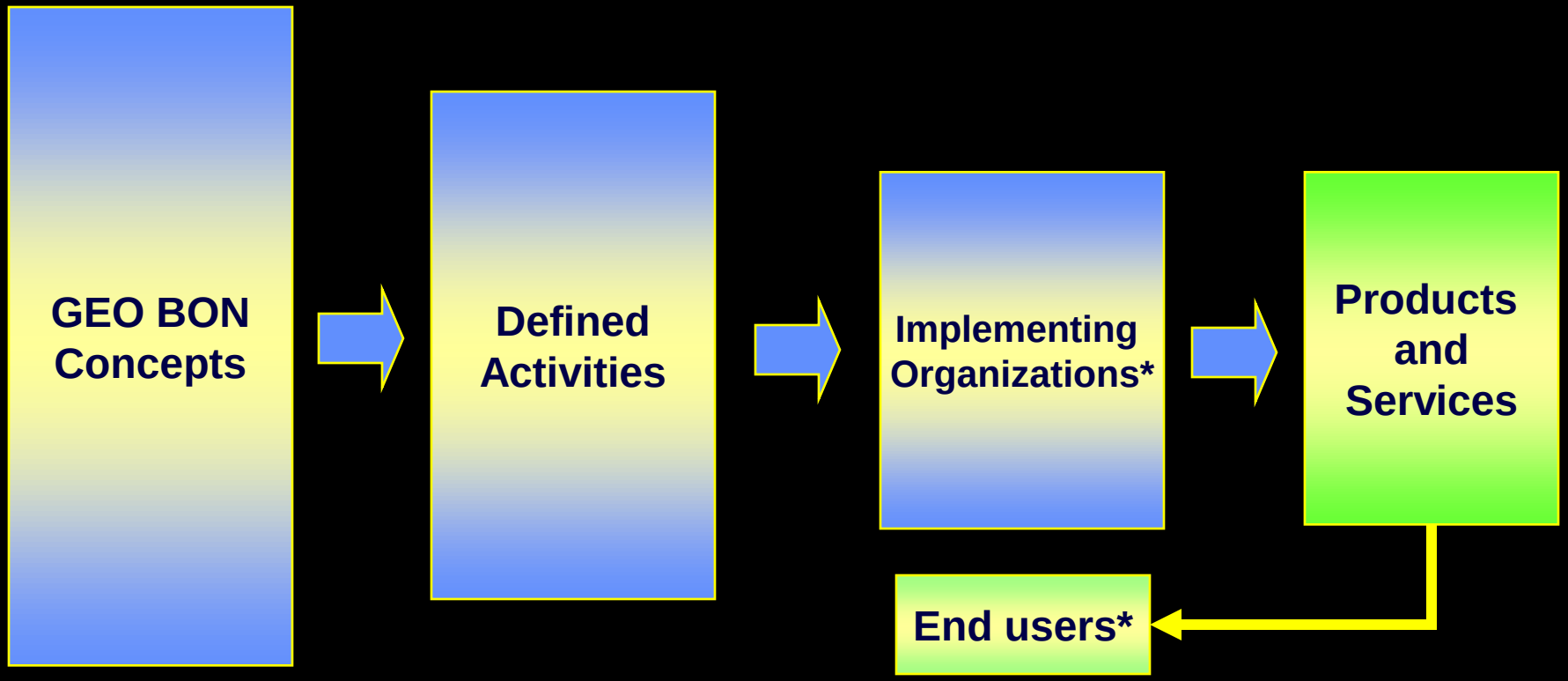
Oxynodera moczarski

Approach

- Incremental
- Opportunistic
- Organic
- Gradual

Doryphora pastica

Big Picture



*These will often be the same organization

Topical WGs

1. Map *concepts* to *activities*
2. Create a detailed implementation plan

- Terrestrial ecosystem change
- Marine ecosystem change
- Freshwater ecosystem change
- Terrestrial species monitoring
- Genetics
- Ecosystem services
- In-situ / remote sensing integration
- Data integration and interoperability

Topical WGs

- **Terrestrial ecosystem monitoring**
  - Rob Jongman (Alterra, EBONE WP4, rob.jongman@wur.nl)
- **Marine ecosystem monitoring**
  - Jan W. de Leeuw (Royal NIOZ and Utrecht University, deleeuw@nioz.nl) & Carlo Heip (Royal NIOZ and NIOO-CEME, c.heip@nioo-knaw.nl)
- **Freshwater ecosystem change**
  - TBD
- **Terrestrial species monitoring**
  - Henrique Pereira (Universidade de Lisboa, hpereira@fc.ul.pt)
- **Genetics**
  - Dan Faith (The Australian Museum, pfaithma@yahoo.com.au)
- **Ecosystem services monitoring**
  - Hal Mooney (DIVERSITAS International, hmooney@stanford.edu)
- **In-situ / remote sensing integration**
  - Simon Ferrier (Simon.Ferrier@csiro.au)
- **Data integration and interoperability**
  - Hannu Saarenmaa (hannu.saarenmaa@helsinki.fi)

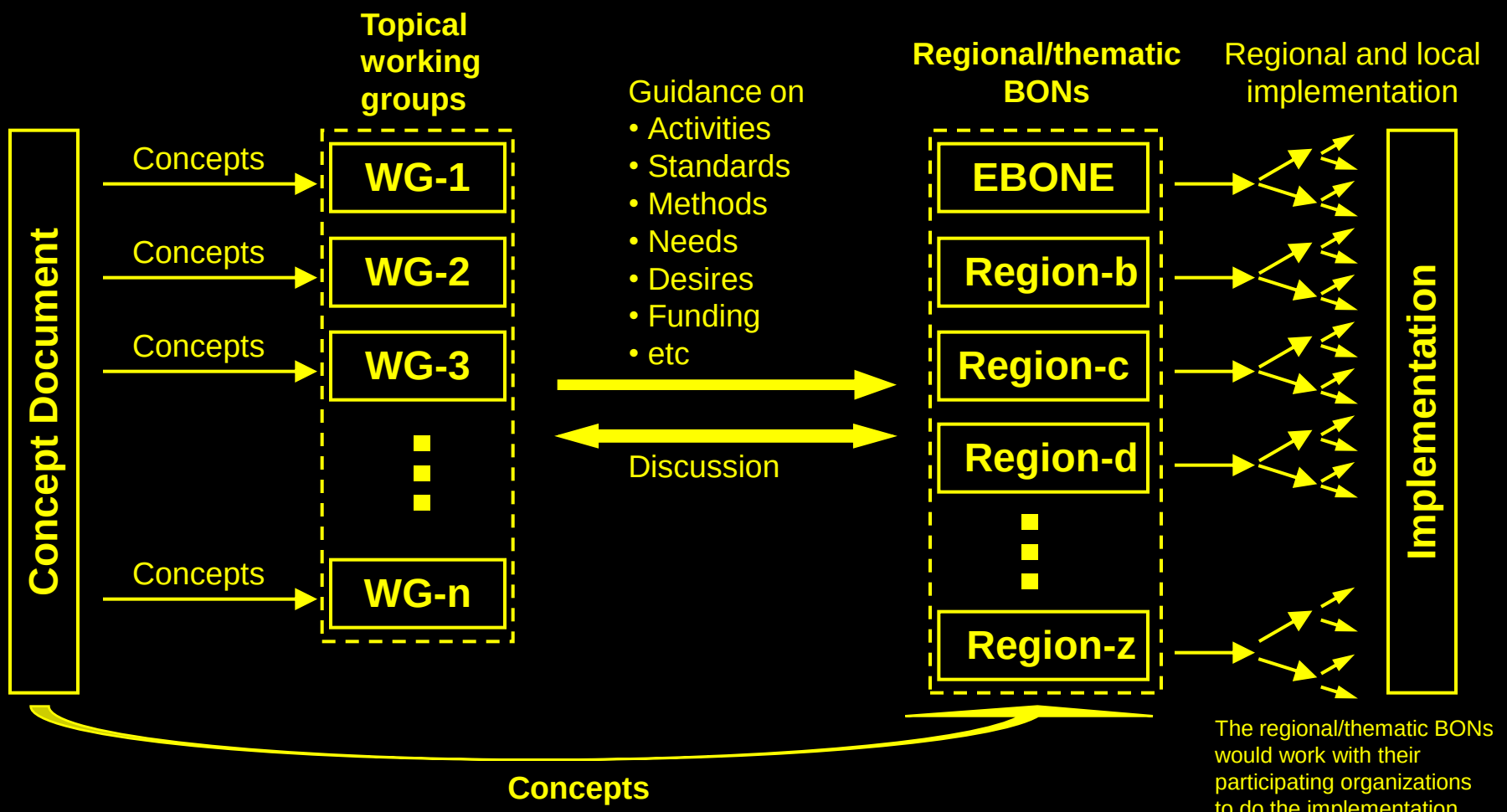
But, who does all the work?

- GEO BON is an organizing framework
- Must be synonymous with the actual Biodiversity Community of Practice

- Community of Practice
  - Governments
  - Existing organizations
  - Researchers
  - Interested citizens

Alurnus bipunctatus

Regional/Thematic BONs



Citizen Science

- "Traditional" methods not adequate for collecting all needed data
- Precedents
  - Christmas Bird Count
  - Breeding Bird Survey
  - Feeder Watch
- New efforts are needed
  - http://whatsbloomin.com

Alurnus ornatus

Citizen Science

Natural Guides, LLC

EOL Uploader

Category: Photography
Released Jan 29, 2009
Seller: Natural Guides, LLC
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Version: 1.0
0.3 MB

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Dec 15, 20

Latitude: 42.26

Green frog

Scientific Name

NATIONAL BESTSELLER

Last Child in the Woods

SAVING OUR CHILDREN FROM NATURE-DEFICIT DISORDER

RICHARD LOUV

RECIPIENT OF THE 2008 AUDUBON MEDAL

ATION DESCRIPTION

talog the amazing biodiversity of our planet by
g to the Encyclopedia of Life (EOL) using your
L is an ambitious project to organize and make
able via the Internet information about all forms of
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scan this Flickr group for new photos to add to
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s on the front page of the EOL group in Flickr. If
sure what you are looking at, tag it as best you can
", "aves", "mammal") and we will try to match it up
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, don't worry, tell us what you know and another
opefully fill in the gaps. Any photos we are able to
a page will eventually be shown on the EOL as
viewed" images. In the future, curators will approve
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FUTURE EXPLORATION NETWORK

www.futureexploration.net

Early products

- Plan to develop product exemplars
  - Spatial distributions & change
  - Populations & drivers of change
  - Biodiversity in African protected areas & tools to track changes
  - Ecosystems change maps

Callopistus castelnaudi

- Primary obstacle is funding

Data formats

- Vary from system to system
- Obstacle for interoperability and global assessments
- Approach (for consideration)
  - Develop community standards for new systems
  - Develop conversion routines for legacy compatibility

Calodema kirbyi

Role of remote sensing

- Global coverage to landscape scale
- Repeated coverage
- Can derive various indicators
- Detect changes
- Potentially—fill in spatial and temporal observation gaps
  - If can relate to ground observations

Odontolabis wollastoni

Governance

- GEO Secretariat
- GEO BON "co-leads"
- Steering Committee
  - ~20 people
  - Reflect different disciplines, ecosystems, countries
- Community of Practice

Lamprima latreillei

Funding

- Largely, coordination of existing activities
  - Mostly in-kind, to date
- Gap-filling
  - Sampling
  - Tools
  - Mostly extension of existing systems
- Marginal cost low
  - Leverages base cost

Belinota sumptuosa

Challenges

- Scaling from *in-situ* to remote sensing data
- Making disparate data and systems work together
- Filling in gaps—much data needed
- Funding and resources

Homoderus mellyi

Next steps

- Develop detailed implementation plan
- Facilitate regional and thematic BONs
- Facilitate funding for implementing orgs
- Continue engagement and community development

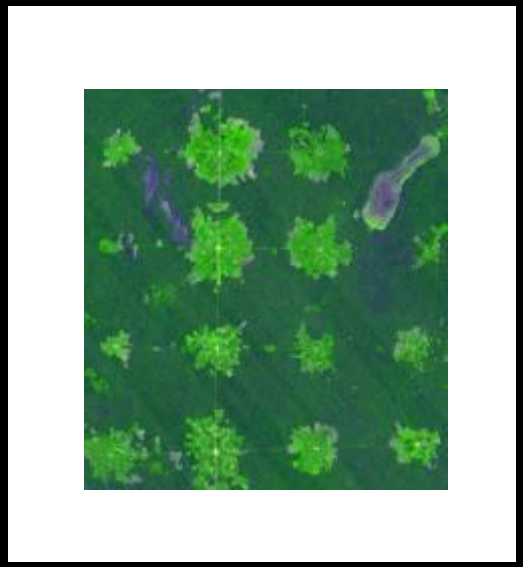
Doryphora 21punctata

Website:

http://www.earthobservations.org/cop_bi_geobon.shtml

or

Goggle: GEO BON



Near Santa Cruz de la Sierra, Bolivia

Cenistra dohrni