Workshop for Establishing a Global Science and Data Network for Coastal Blue Carbon (SBC)

USGS Headquarters - Western Region
Menlo Park, California
12-14 January 2016

Steering Committee:
Jim Tang, Marine Biological Laboratory
Kevin Kroeger, US Geological Survey
Emily Pidgeon, Conservation International
Jennifer Howard, Conservation International
Lisamarie Windham-Myers, US Geological Survey

Workshop for Establishing a Global Science and Data Network for Coastal Blue Carbon (SBC)

8:30-10:30am
Welcome

USGS – Lisamarie Windham-Myers
CCIWG – Gyami Shrestha (USGCRP)
and Kathy Hibbard (NASA HQ)
CEC – Karen Richardson

Introductions (less than 2 mins each)

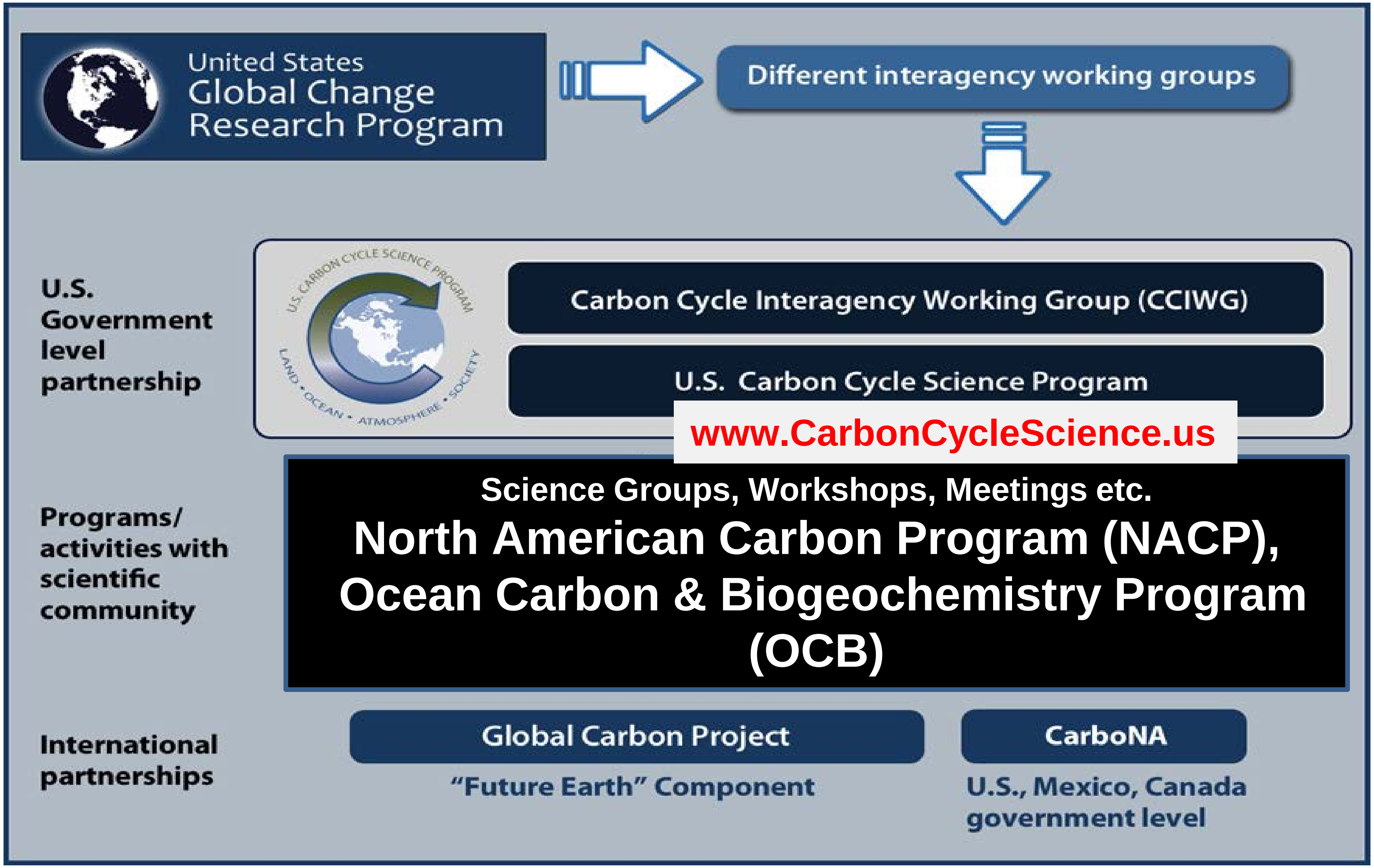
10:30-11am Break
11am-12:30pm Steering Committee Presentation

LUNCH 12:30-1:30

1:30-3:30 Breakout Groups - Network Needs and Goals
3:30-5pm Auditorium – Summarize results of Breakout Groups

5pm ADJOURN

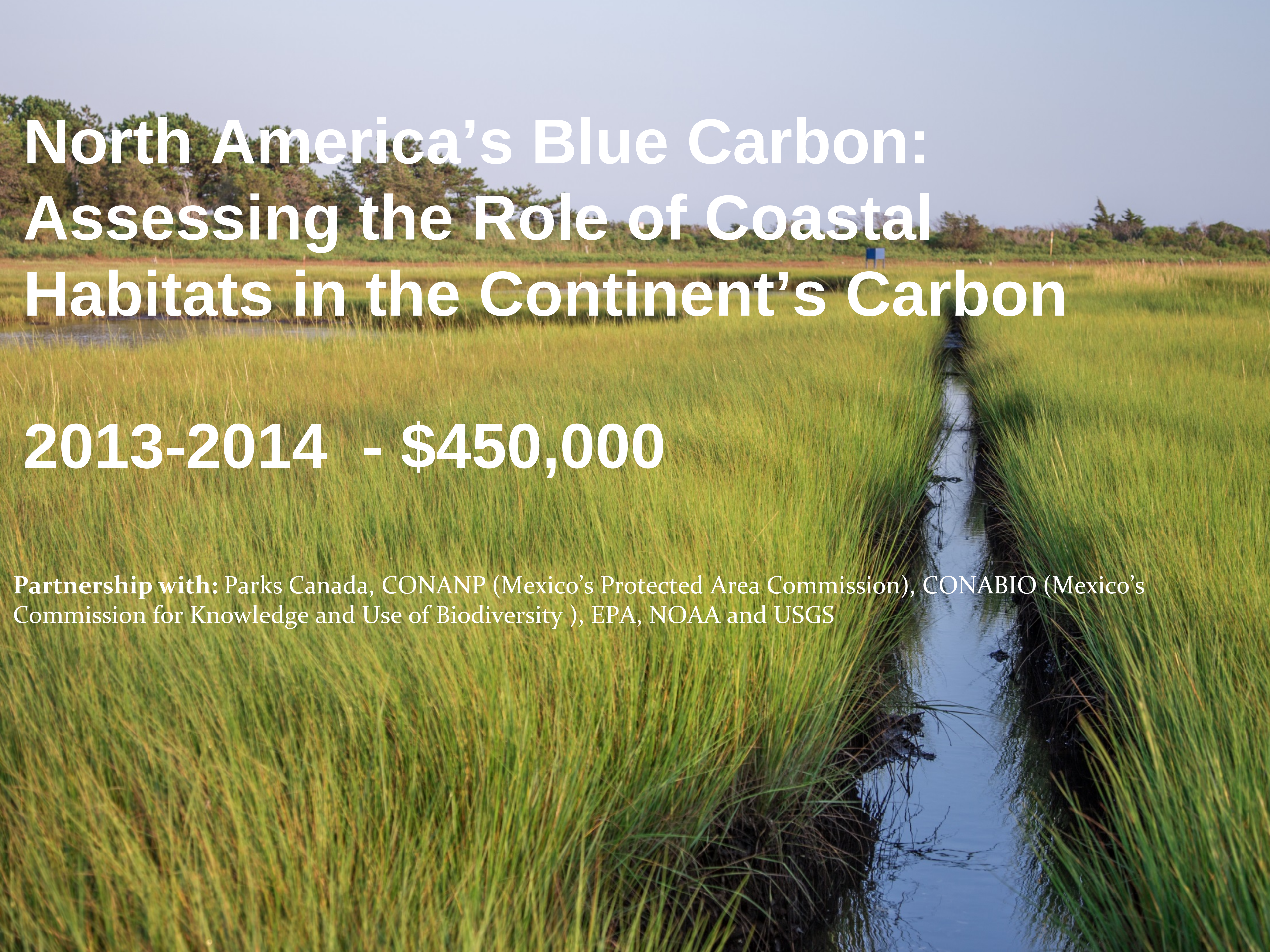
CCIWG: An Interagency Partnership to coordinate and facilitate federally funded carbon cycle research, and provide leadership to the USGCRP on carbon cycle science



e.g.
NACP-OCB Coastal Carbon Science Plan,
Coastal Carbon Syntheses,
SOCCR-2

Commission for Environmental Cooperation (CEC, CCE, CCA)

The Commission for Environmental Cooperation (CEC) is an international organization created by the governments of Canada, Mexico and the United States in 1994 to help strengthen their stewardship of the North American environment.



North America's Blue Carbon: Assessing the Role of Coastal Habitats in the Continent's Carbon

2013-2014 - $450,000

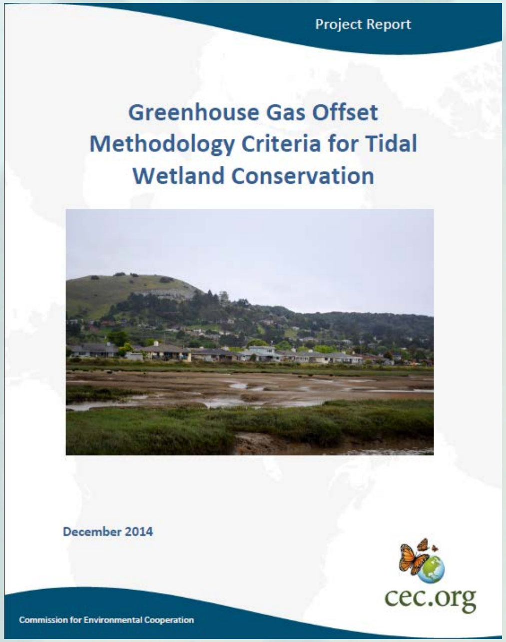
Partnership with: Parks Canada, CONANP (Mexico's Protected Area Commission), CONABIO (Mexico's Commission for Knowledge and Use of Biodiversity), EPA, NOAA and USGS

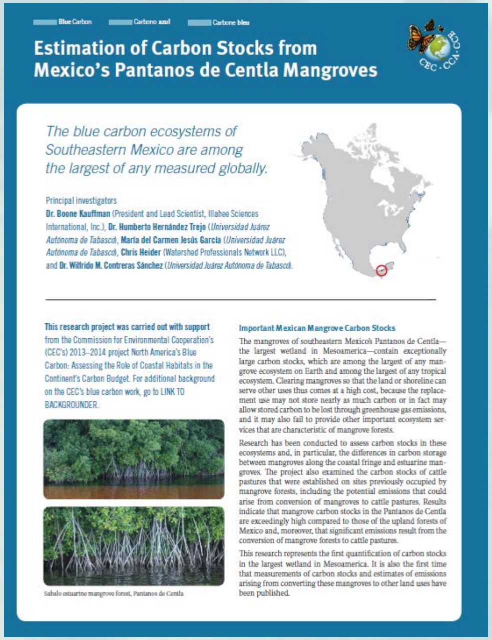
North American Blue Carbon: Next Steps in Science for Policy

2015-2016 - $620,000

Partnership with: Parks Canada, CONANP (Mexico's Protected Area Commission), CONABIO (Mexico's Commission for Knowledge and Use of Biodiversity), EPA, NOAA and USGS

cec.org




Blue Carbon · Carbono azul · Carbone bleu

Estimation of Carbon Stocks from Mexico's Pantanos de Centla Mangroves

The blue carbon ecosystems of Southeastern Mexico are among the largest of any measured globally.

Principal investigators
Dr. Boone Kauffman (President and Lead Scientist, Illahee Sciences International, Inc.), **Dr. Humberto Hernández Trejo** (*Universidad Juárez Autónoma de Tabasco*), **María del Carmen Jesús García** (*Universidad Juárez Autónoma de Tabasco*), **Chris Heider** (Watershed Professionals Network LLC), and **Dr. Wilfrido M. Contreras Sánchez** (*Universidad Juárez Autónoma de Tabasco*).

This research project was carried out with support from the Commission for Environmental Cooperation's (CEC's) 2013–2014 project North America's Blue Carbon: Assessing the Role of Coastal Habitats in the Continent's Carbon Budget. For additional background on the CEC's blue carbon work, go to LINK TO BACKGROUNDER.

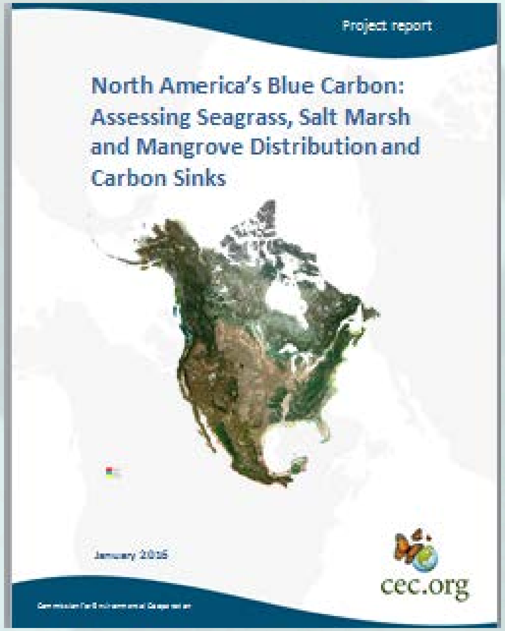
Sabalo estuarine mangrove forest, Pantanos de Centla

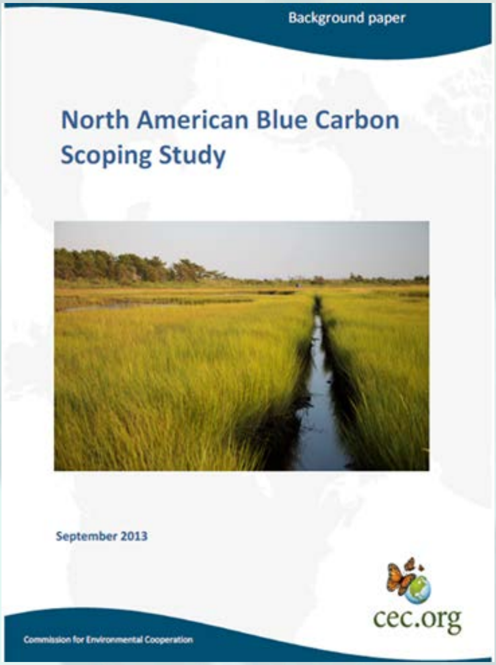
Important Mexican Mangrove Carbon Stocks

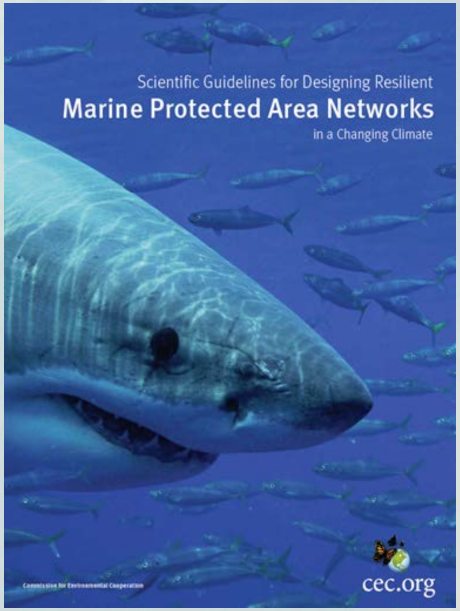
The mangroves of southeastern Mexico's Pantanos de Centla—the largest wetland in Mesoamerica—contain exceptionally large carbon stocks, which are among the largest of any mangrove ecosystem on Earth and among the largest of any tropical ecosystem. Clearing mangroves so that the land or shoreline can serve other uses thus comes at a high cost, because the replacement use may not store nearly as much carbon or in fact may allow stored carbon to be lost through greenhouse gas emissions, and it may also fail to provide other important ecosystem services that are characteristic of mangrove forests.

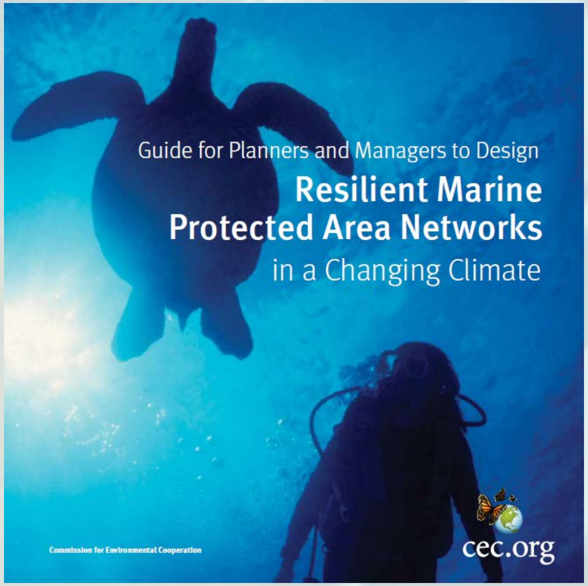
Research has been conducted to assess carbon stocks in these ecosystems and, in particular, the differences in carbon storage between mangroves along the coastal fringe and estuarine mangroves. The project also examined the carbon stocks of cattle pastures that were established on sites previously occupied by mangrove forests, including the potential emissions that could arise from conversion of mangroves to cattle pastures. Results indicate that mangrove carbon stocks in the Pantanos de Centla are exceedingly high compared to those of the upland forests of Mexico and, moreover, that significant emissions result from the conversion of mangrove forests to cattle pastures.

This research represents the first quantification of carbon stocks in the largest wetland in Mesoamerica. It is also the first time that measurements of carbon stocks and estimates of emissions arising from converting these mangroves to other land uses have been published.










Seagrass
Salt marshes
Mangroves
cec.org


Three countries. One environment.
Tres países. Un medio ambiente.
Trois pays. Un environnement.
cec.org

Workshop for Establishing a Global Science and Data Network for Coastal Blue Carbon (SBC)

U.S. CARBON CYCLE SCIENCE PROGRAM
LAND • OCEAN • ATMOSPHERE • SOCIETY

CEC · CCA · CCE

Introductions

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Why a Global Science and Data Network for Coastal Blue Carbon?

Science

- Access to global high quality data and research
- Improve basic & applied science on C & GHG cycling in coastal vegetated wetlands
- Access to science users to understand needs

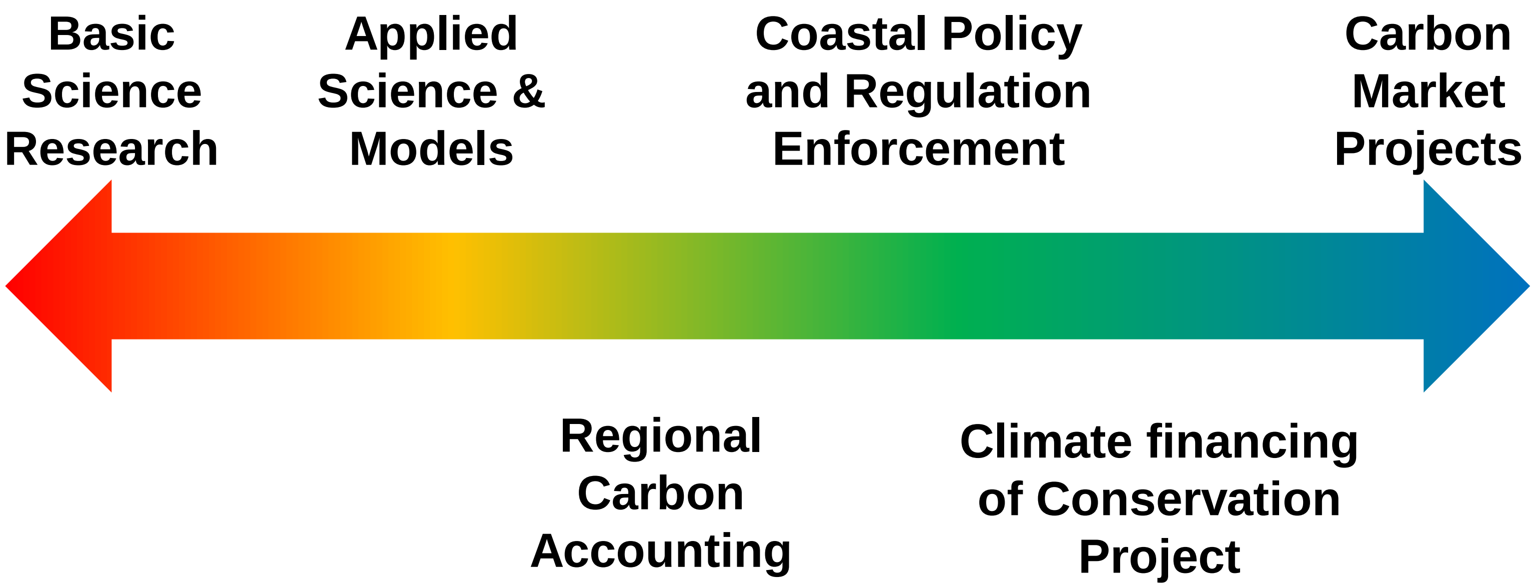
Policy

- Generate large scale accounting of carbon emissions and sequestration
- Need data to support Blue Carbon inclusion in policy and regulation
- Need to access topic experts

Conservation Projects

- Quantify current and future carbon in project areas
- Need to access topic experts

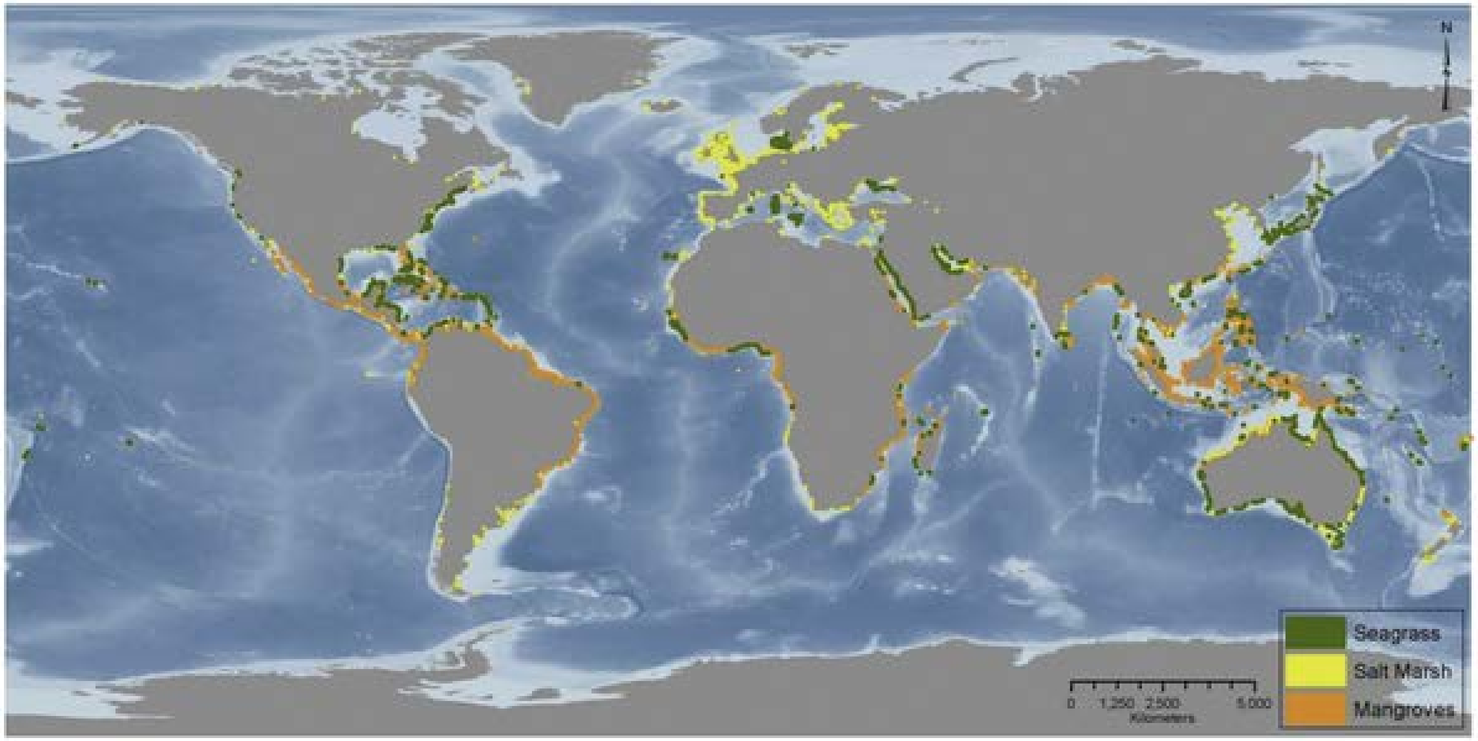
Broad Spectrum of Users and Needs



Motivation for Global Science and Data Network for Coastal Blue Carbon

Across spectrum need for

a. Accuracy, accessibility and confidence in blue carbon data
b. Global data coverage
c. Broad-based science network



Vision for SBC Network and Database

Goal:

Establish a Global Science and Data Network for Coastal Blue Carbon (SBC), to support carbon and GHG cycle science in coastal ecosystems.

Specific Objectives of the Network:

1. Improve basic and applied science including basic science questions and science that addresses the needs of policy, carbon accounting and coastal management;
2. Build a coastal carbon and GHG database for use by the science community, coastal practitioners and other data users;
3. Identify priority research needs and geographies;
4. Build capacity of coastal carbon stakeholders globally to collect and interpret high quality coastal carbon science and data.
5. Build capacity to ensure the best available data is globally accessible and that science is responsive to the needs of coastal managers and policy-makers.

Vision for SBC Network and Database

Users:

- Scientific research community
- Policymakers and related data users, including support for inclusion of wetlands in national GHG inventories (using 2013 IPCC guidelines) and other policy applications
- Coastal managers and conservation organizations for the development of carbon-based projects, including carbon-market offset projects

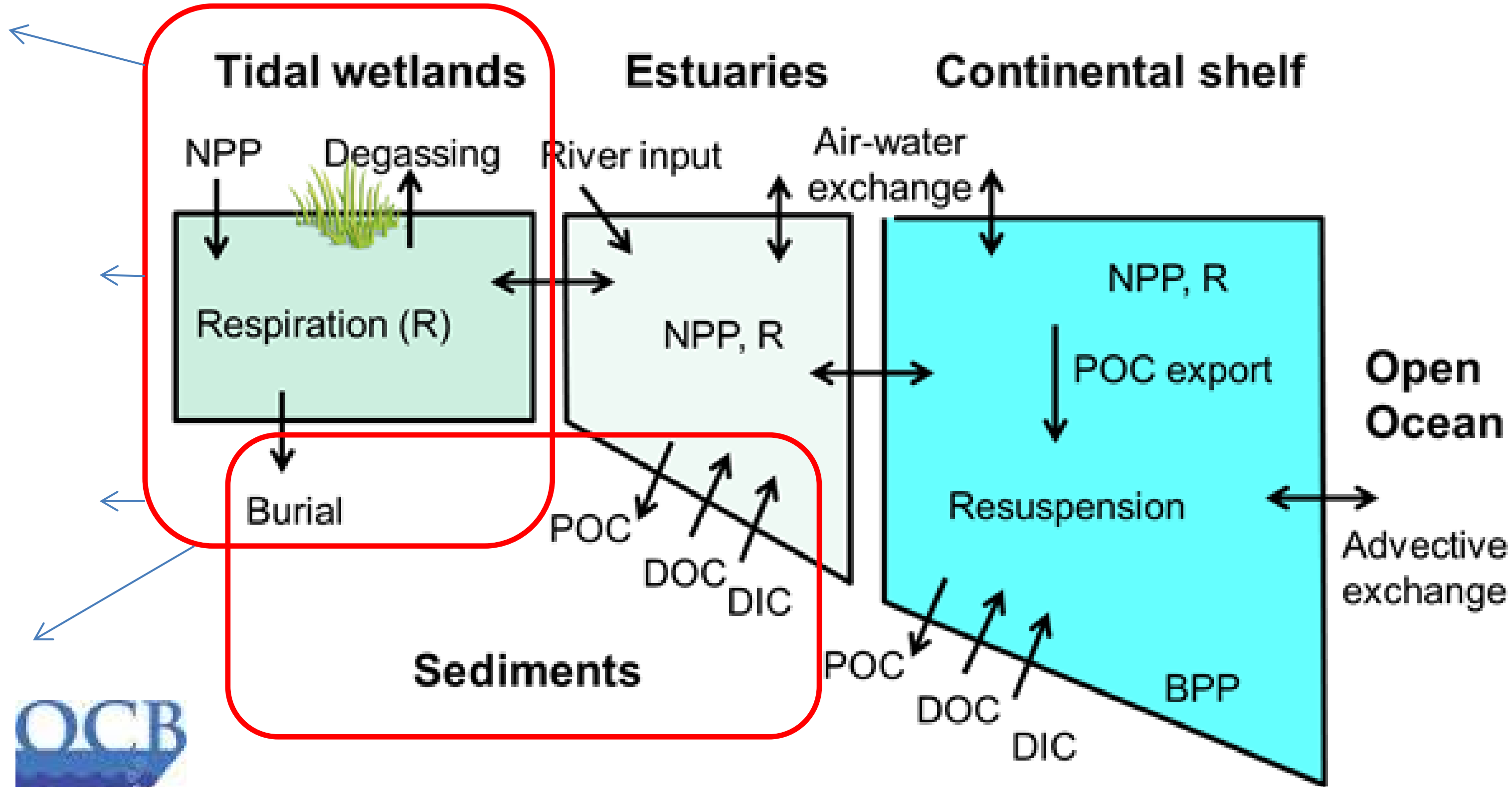
Why focus on Blue Carbon Habitats "only"?

Marsh

Mangrove

Seagrass

Other



North American Carbon Program

subset of habitats in Coastal CARbon Synthesis

Focus on Blue Carbon Habitats “only”

Processes important to managing and monitoring blue carbon (and GHG) fluxes and stocks

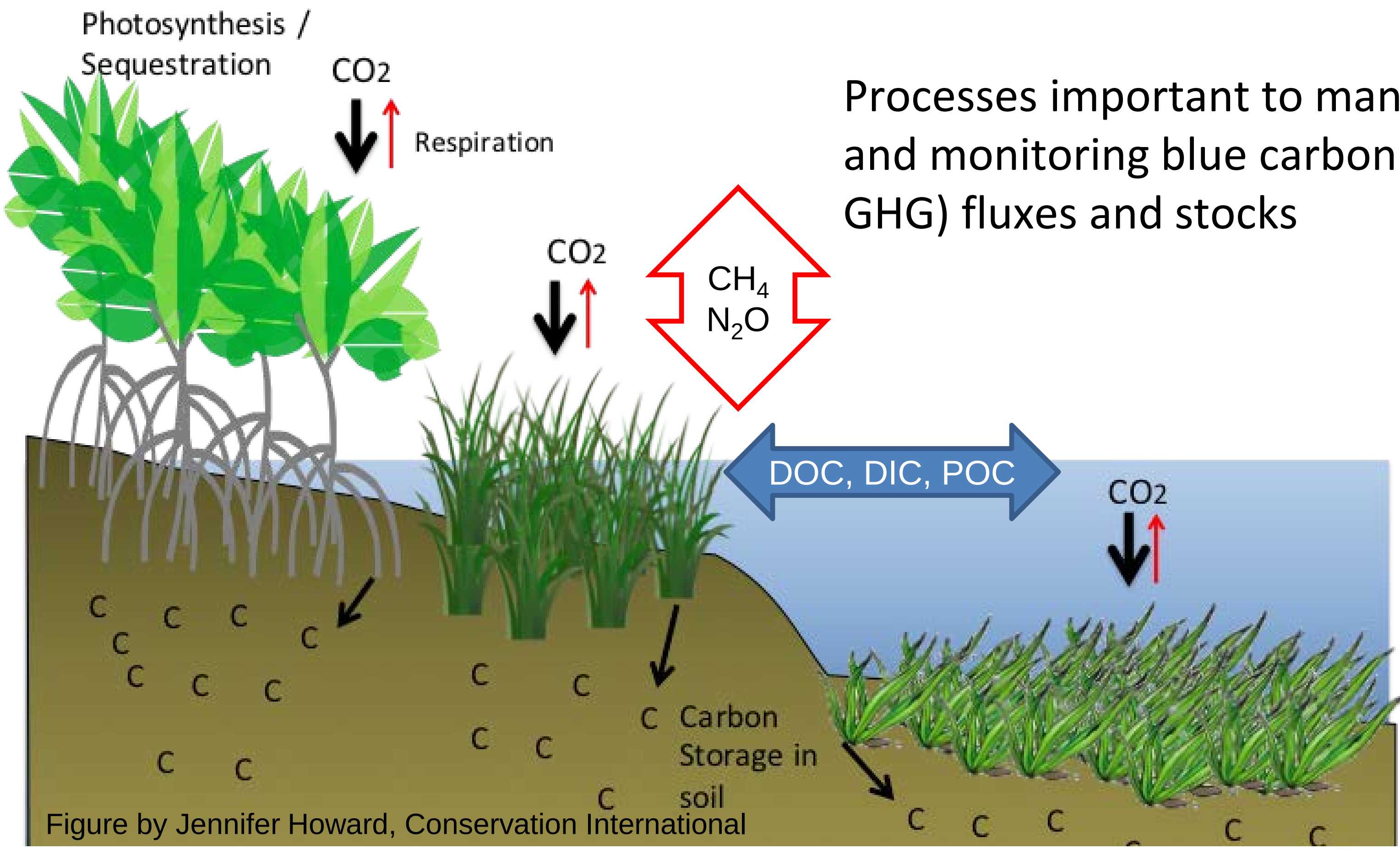


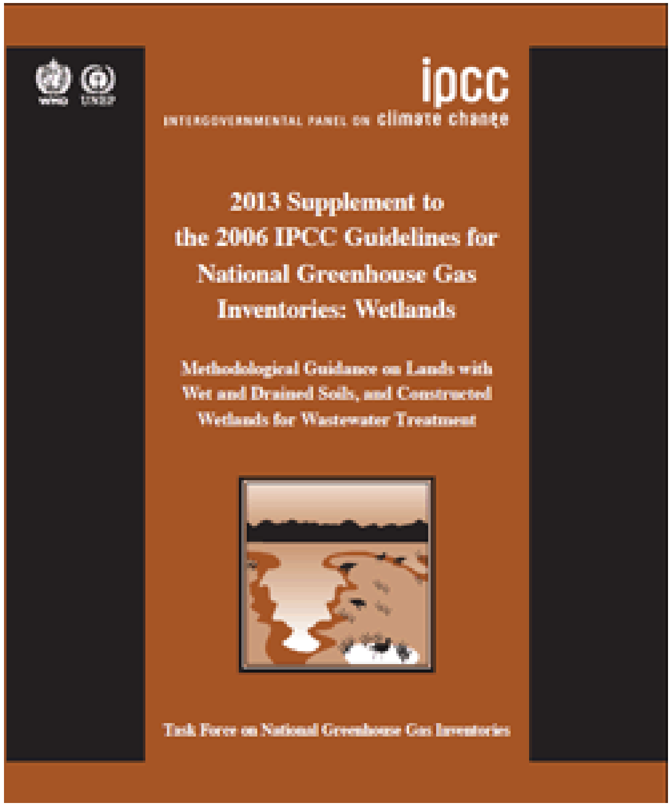
Figure by Jennifer Howard, Conservation International

- Atmospheric Flux (Eddy Covariance, Chambers)
- Hydrologic (Lateral) Flux (dissolved and particulate, inorganic and organic)
- Vegetation Pools (Species, Mapping, Biomass above and belowground)
- Soil Pools (Depth, Accretion/Erosion/Oxidation, Carbon density, Provenance)

Management and Policy Needs

Priority Agenda
Enhancing the Climate Resilience *of* America's Natural Resources
COUNCIL ON CLIMATE PREPAREDNESS AND RESILIENCE

VCS | VERIFIED CARBON STANDARD
A Global Benchmark for Carbon



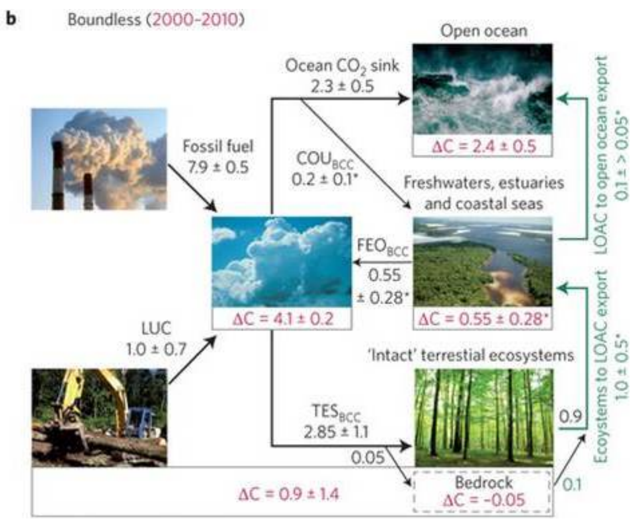
Example: Conservation Project Development

Science Motivation for SBC Network

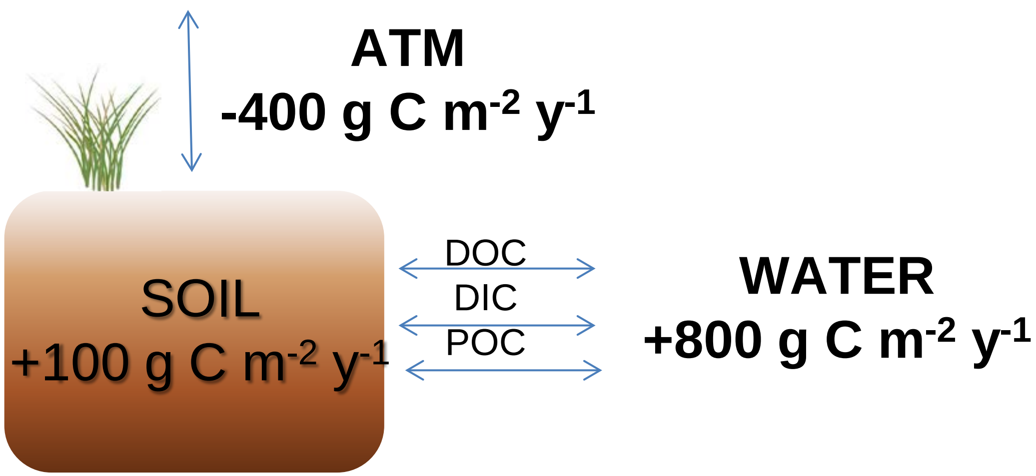
– Data access and quality assurance ("apples to apples")

– Process-based science (site/time relationships, best approaches)

– Closing carbon budgets – resolving differences between methods, timescales, spatial scales



Regnier et al 2013 Nature Geosciences



e.g. Fluxes at different temporal and spatial scales

Inclusive Network Structure

potential members and collaborations include:

Coastal Carbon Scientists and Researchers

- Research programs funded through NASA, USGS, NOAA
- Coastal CARbon Synthesis (CCARS)
- Australian Coastal Carbon Research Cluster (CSIRO)
- International science organizations

Policy-makers, Conservation Groups, Coastal Managers

- International Blue Carbon Initiative
- US Blue Carbon Network (BCN)
- Carbon inventory activities by the US EPA
- Wetlands carbon methodology development (VCS)
- Land management agencies, public and private (e.g. USFWS, TNC)

Objectives of the past CERF and AGU Town Hall Meetings

- Present vision of SBC
- Solicit input for 2016 proposal to CCIWG for network and associated database design and implementation
- Gather information on interested participants

Questions asked at CERF and AGU Town Hall

Question 1 – What questions would SBC help you address? Any?

- Geographies, ecosystems, processes, rates, mechanisms, controls
- Policy and practice-related science questions for database

Question 2 – Who would be end users of network?

Question 3 – Database - Care and feeding advice?

- Experiences with database implementation?
- How to make user friendly?

Question 4 – What have we not thought of?

Results of Pre-Meeting Survey

http://goo.gl/forms/2euw0UQMr4

Question 1: What is the most important rationale for this network?

1. Promote benefits of ecosystem C sequestration of coastal blue carbon as one climate intervention

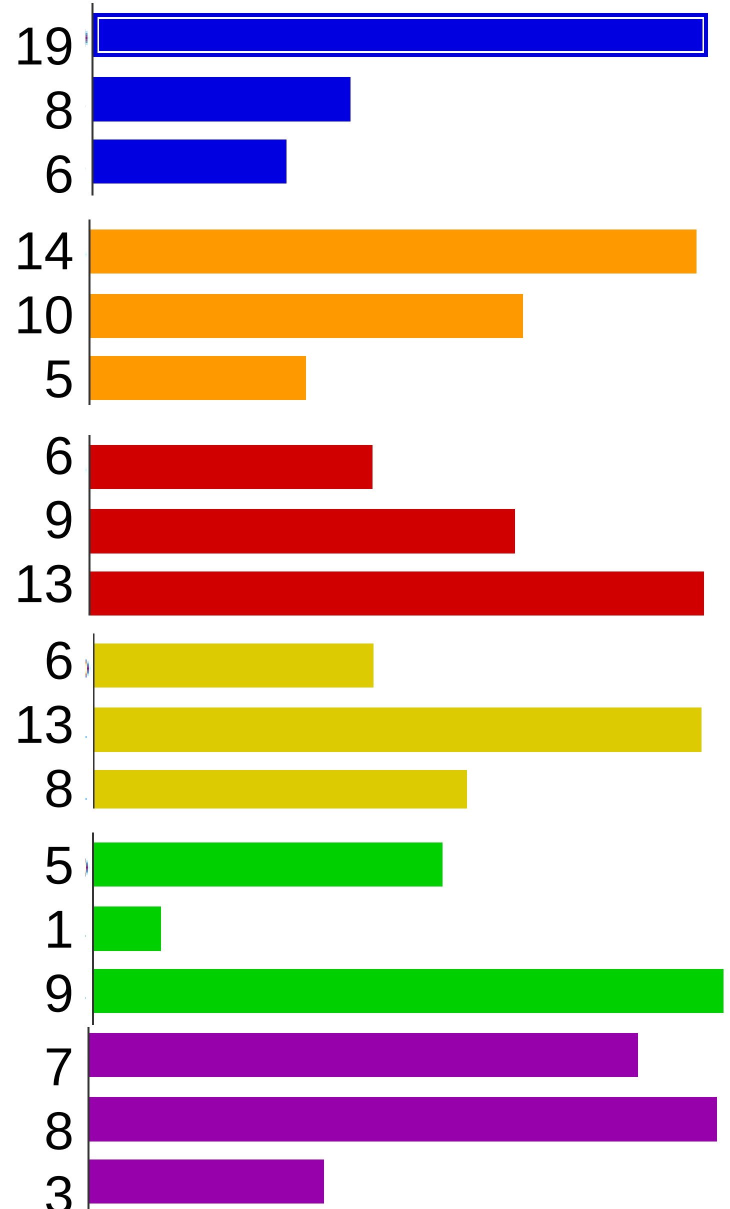
2. Provide a tool to promote conservation of valuable ecosystems

3. Influence priorities of funding agencies

4. Standardize terminology, methods, etc.

5. Identify BC opportunities

6. Networking itself – promote idea exchange among practitioners



Question 2: What is the most important rationale for a large, quality-controlled database?

50%	National scale or regional scale BC accounting
40%	Understand and model coastal carbon and GHG processes by overcoming data limitations and heterogeneity
27.5%	Synthesis of existing knowledge to suggest future directions for research and data collection
17.5%	Utility in providing site specific information to support BC projects
7.5%	Other

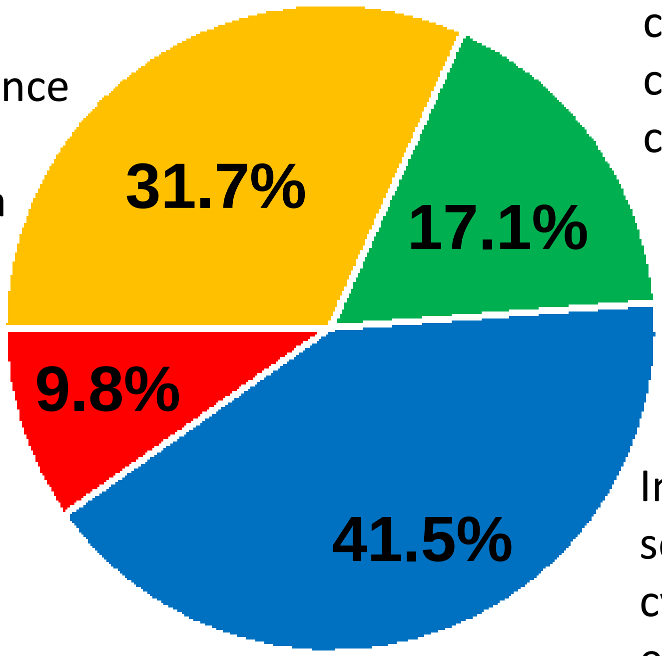
Question 3: What is the greatest value for this large database?

64.1%	Provide a mechanism to increase accessibility of high quality data
38.5%	Provide a mechanism to increase confidence in our knowledge of coastal blue carbon.
17.9%	Increase availability and quality of metadata for legacy and future datasets.
15.4%	Provide a mechanism to both quantify the accuracy of legacy data and increase the accuracy of future data
2.6%	Other

Question 4: All of the goals listed below will be integrated into the network, but which one are you most interested in working on?

Providing a mechanism for collecting and providing a coastal carbon and GHG database for use by the science community, coastal practitioners and other data users

Building the capacity of coastal carbon stakeholders globally to collect and interpret high quality coastal carbon science and data



Identifying priority research needs and geographies

Improving basic and applied science on carbon and GHG cycling in vegetated coastal ecosystems including basic science questions and science that addresses the immediate and future needs of policy, carbon accounting and coastal management

Question 5: What are the most important functions of the network?

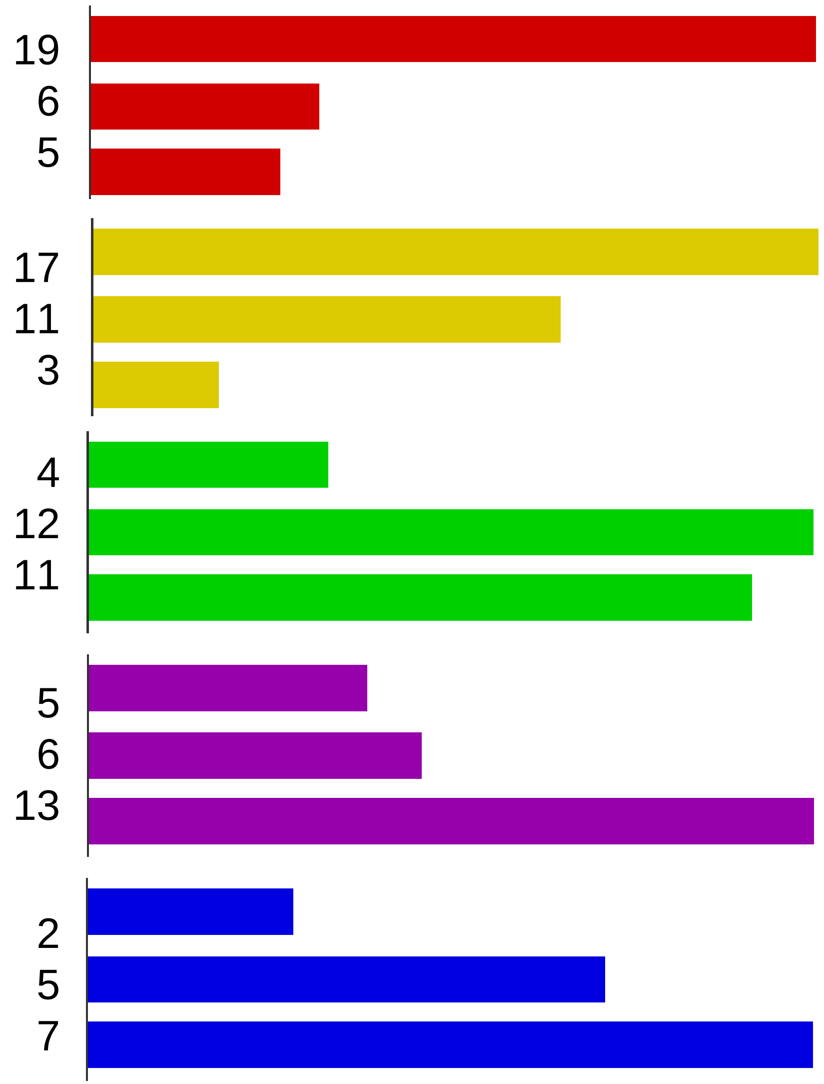
Establishing common terminology and best practice methodologies and standards for coastal carbon and GHG data collection and interpretation

Creating the first comprehensive global data archive providing freely available, comparable, quality-controlled, and traceable access to spatially explicit coastal carbon and GHG data and metadata

Synthesis and integrated modeling activities that increase predictive capabilities

Outreach and capacity building activities to ensure that science is responsive to the needs of coastal managers and policy-makers

Providing a forum and mechanism to promote exchange and collaboration between scientists and coastal carbon data users globally



Our goal for this SBC Workshop

Goal: Produce a community-driven vision and preliminary design of the network and database

Output: Proposal to CCIWG to support the creation and maintenance of the Coastal Blue Carbon Network and Database

Output by 1/14: 30 minute presentation to CCIWG members to gain agency-level insight and feedback

Our goal for this SBC Workshop

	Tuesday	Wednesday	Thursday
I	Introductions	Review Presentations: Database Examples	Presentation to CCIWG Web/Audio discussion
Break			
II	Introduction from Steering committee	Breakout Group: Database Governance	Final decisions
Lunch			
			Adjourn meeting
III	Breakout Group: Network: Need&Structure	Breakout Group: Database Design	
Break			
IV	Results of Breakout Groups	Results of Breakout Groups	

Breakout Groups: Identifying Need, Goals, and Objectives of Network (and Database)

- What important science, knowledge and related gaps would benefit from a network? How? What questions or applications would the network allow you to address?
- How should a network be structured? What would be the elements? Activities?
- How should the network communicate?
- How do other Blue Carbon related initiatives and organizations interact and collaborate with this network?

Breakout Group Structure:

1. Science Focus – California Room

2. Policy/Inventory Focus – Nevada Room

3. Conservation and Restoration Project Focus – Rambo Auditorium

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Day 1 Summary: Network

- Provide scientific leadership for Blue Carbon
- Credible, reliable & traceable data
- Policy relevant but objective science-based network
- Sustainable (funding, staff, ongoing participation and community engagement)
- Initially prioritize activities and limit scope of database. Grow gradually.
- Other initial activities
  - standards for data, methods and best practices
  - active portal for information
  - facilitate collaboration with other networks
  - Training & outreach

Bob Simons (NOAA)

ERDDAP as one solution to build a database and serve data

Andy Stevens (CSIRO)

Blue Carbon in the Antipodes: from data to knowledge

Discussion

Database: Recommendations for Governance and Management.

1. *How can we collaborate and interact with existing relevant databases and datasets?*
2. *What management structures will make the database most accessible?*
3. *What is the data use policy for the database?*
4. *How do we ensure database is international in scope and what challenges are involved?*
5. *What level of QA/QC is needed?*
6. *What resources (budget) will be required?*

•

Database Design and Data Standards

1. *What different data types are necessary?*
2. *What minimum requirements of the data to support the database objectives?*
3. *How would you bridge differences in data types to support the database objectives?*
4. *How would you query the database? What combinations of data, formats and metadata are useful?*

Example from the International Blue Carbon Scientific Working Group

Breakout Group Structure:

1. Science Focus – Rambo Auditorium

2. Policy/Inventory + Conservation and Restoration Project Focus – California Room

Build, and build on, Community

Trust your principles

Start Small but Think Big

Integrate Science, as a Strategy

Build, and build on, community.

- Low cost: listserve, townhalls, special issues, white papers
- Simple website with WIKIs, resources
- Workshops

Trust your principles

- Open and international
- Credible and robust
- Scientifically focused and policy relevance
- Training and professional growth

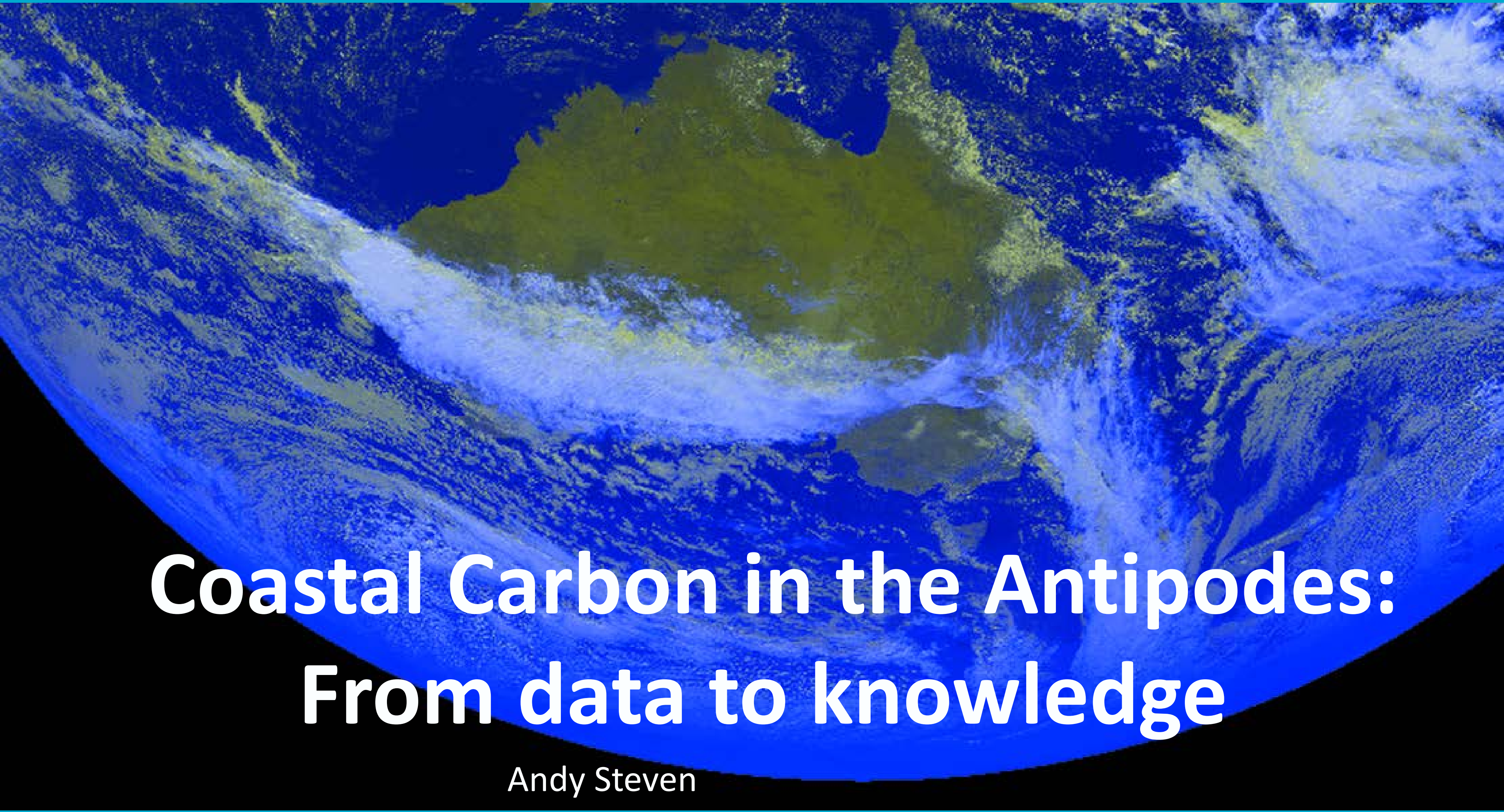
Start Small but Think Big (ok, try to start big, but just in case)

- Proactive about terms, standards, variable definitions, naming, formats.
- Build the database foundation. Enough of a database that each synthesis activity can add to it. (no more on-off’s)
- Plan for continued visibility, products, and activities

- *Stay flexible*
- *Leverage: ERDDAP, AmeriFlux, ISCN, ….*

Integrate Science, strategically

- Start with synthesis activities that create incentives, and that focuses the QA/QC. Use the synthesis to help fund the database
- Having a science goal can help with funding
- Science provides criteria (and multiple stakeholders, too)

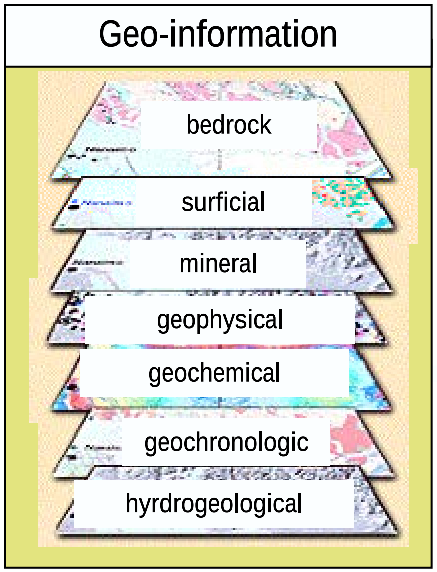


Coastal Carbon in the Antipodes: From data to knowledge

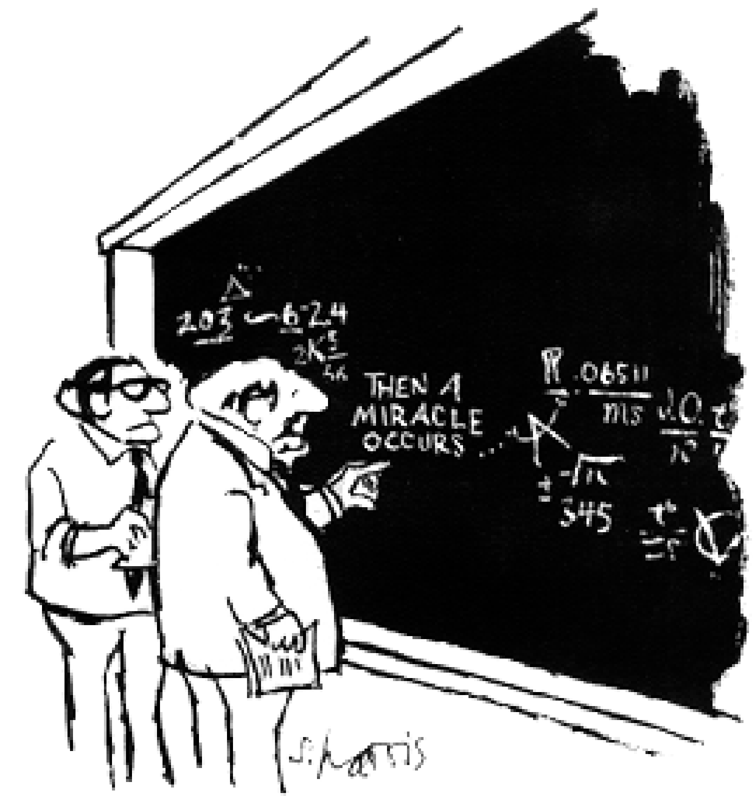
Andy Steven

Blue Carbon Network, Palo Alto , 12-14 February 2016

Gather data, process it, publish results
Simple, isn't it?



data



"I think you should be more explicit here in step two."

knowledge

Overview

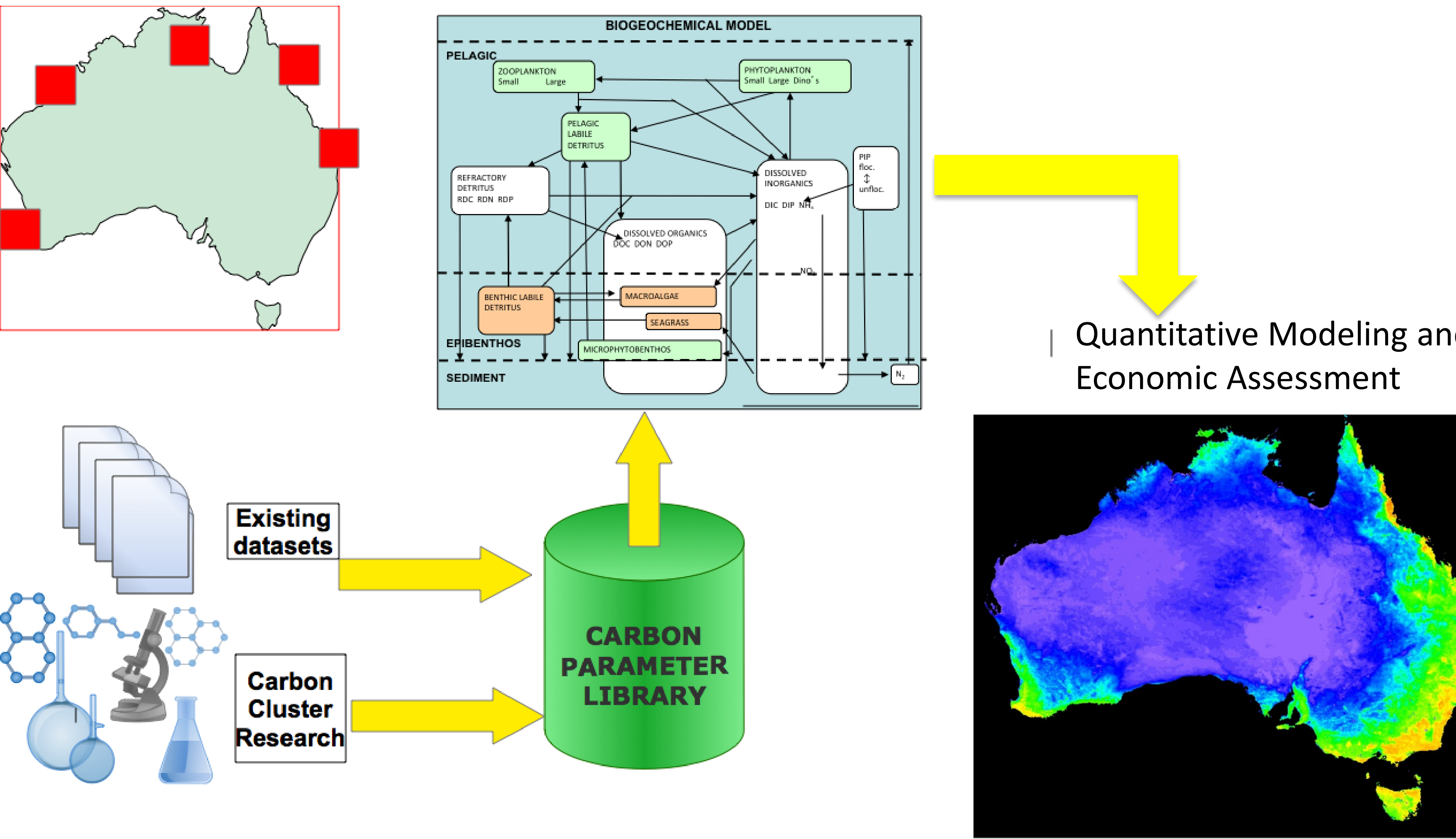
1. Carbon cluster overview and approach
2. General philosophy and principles around data
3. Thinking about carbon data
4. From data to Knowledge
5. Final thoughts

Carbon cluster overview and approach

- The Australian Marine and Coastal Carbon Biogeochemistry Cluster – the Carbon Cluster
- Australia's largest-ever blue carbon accounting, mapping and measurement study.
- Combines CSIRO Oceans and Atmosphere Flagship with the capabilities of eight major Australian research institutions.

UTS University of Technology, Sydney · The University of Western Australia · The University of Queensland Australia · Griffith University · UNSW Australia · Australian Institute of Marine Science · Southern Cross University · Edith Cowan University Australia

Quantifying Coastal Carbon through the CSIRO Marine & Carbon Biogeochemistry Cluster



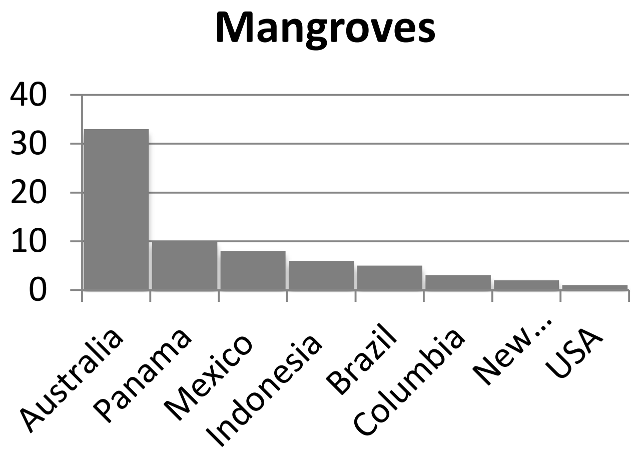
Carbon cluster overview and approach

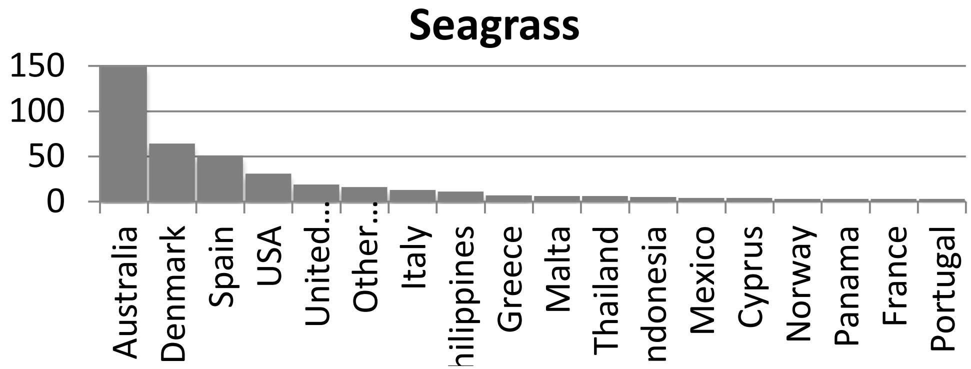
- Collating the limited existing Australian coastal carbon data as well as delivering new data to enhance predictions of national coastal carbon budgets

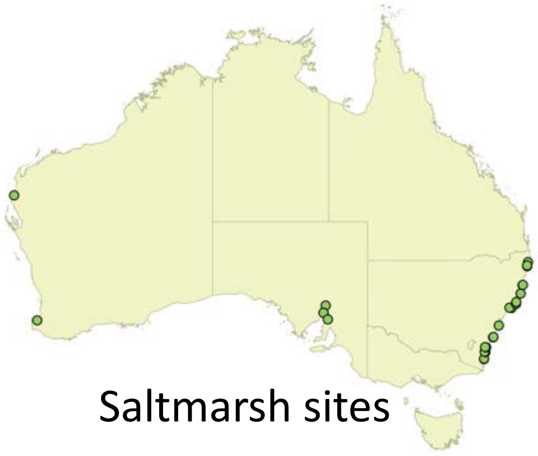
- Four integrated work packages:
  1. Carbon sequestration, stoichiometry and stores
  2. Benthic community metabolism and benthic-pelagic coupling
  3. Pelagic community metabolism
  4. Scaling up to regional inventories & data assimilation, and parameter & model uncertainties

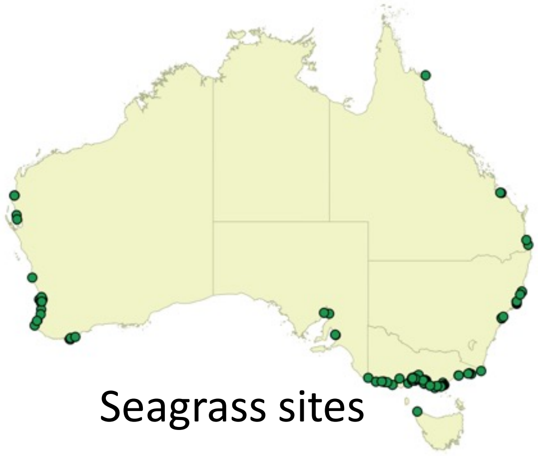
Achievements to Date

- 500+ cores
- 19 PhDs
- 20+ publications






Saltmarsh sites


Seagrass sites


Mangrove sites

From Data to Coastal Information

Data Access and Standards

- In Australia, there has been a significant change in data licensing and access in recent years
- Governments and research organisations have lead the way

- The use of standards-based web services (e.g. OGC) has become more common
- Both metadata and data standards are now common and widely used
- Minting of DOIs for datasets now routine

Interoperability

- The initial result of better data delivery has been many domain specific or thematic data portals

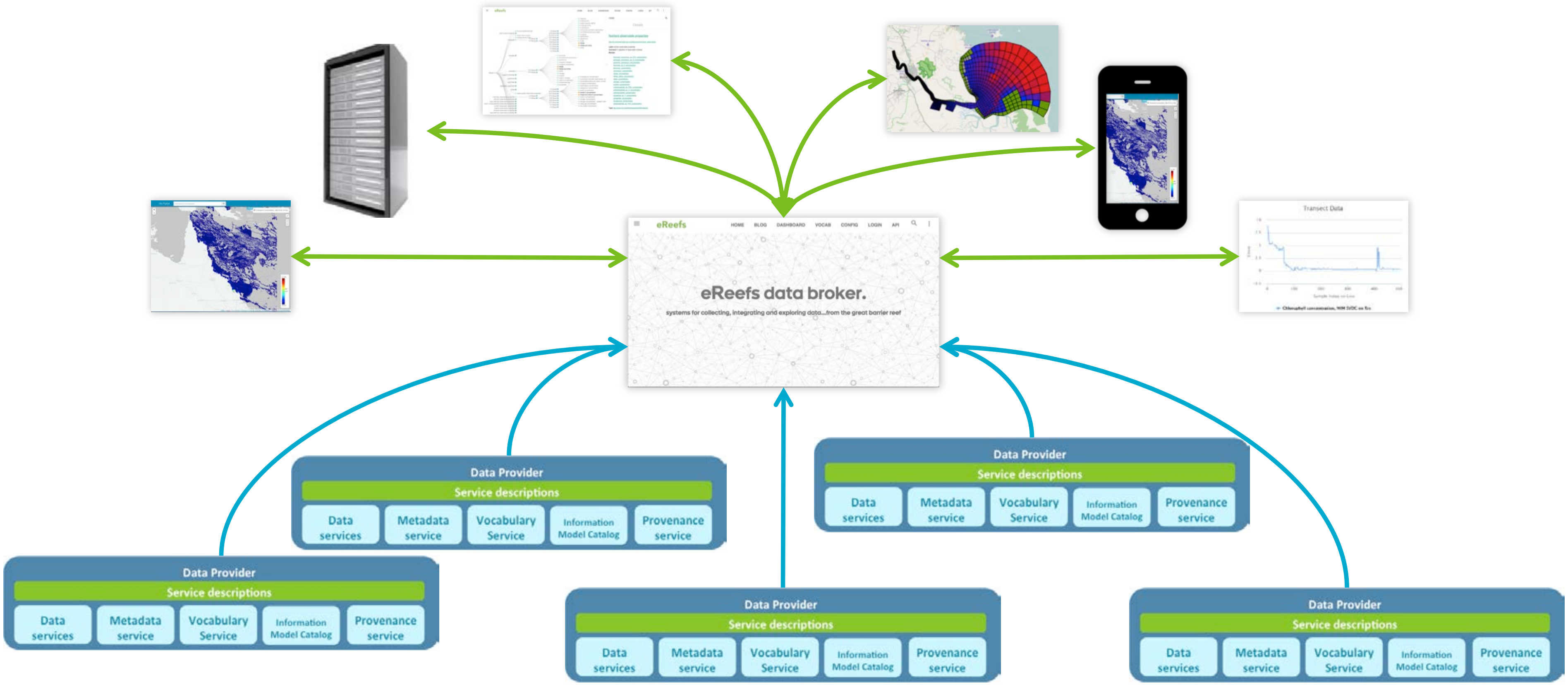
- We now need more complex interoperability, formal vocabularies and data brokering to join domains and break down the data silos

- Recent work is building on “Semantic Web” and “Linked Open Data” methods and technologies to add value to existing systems

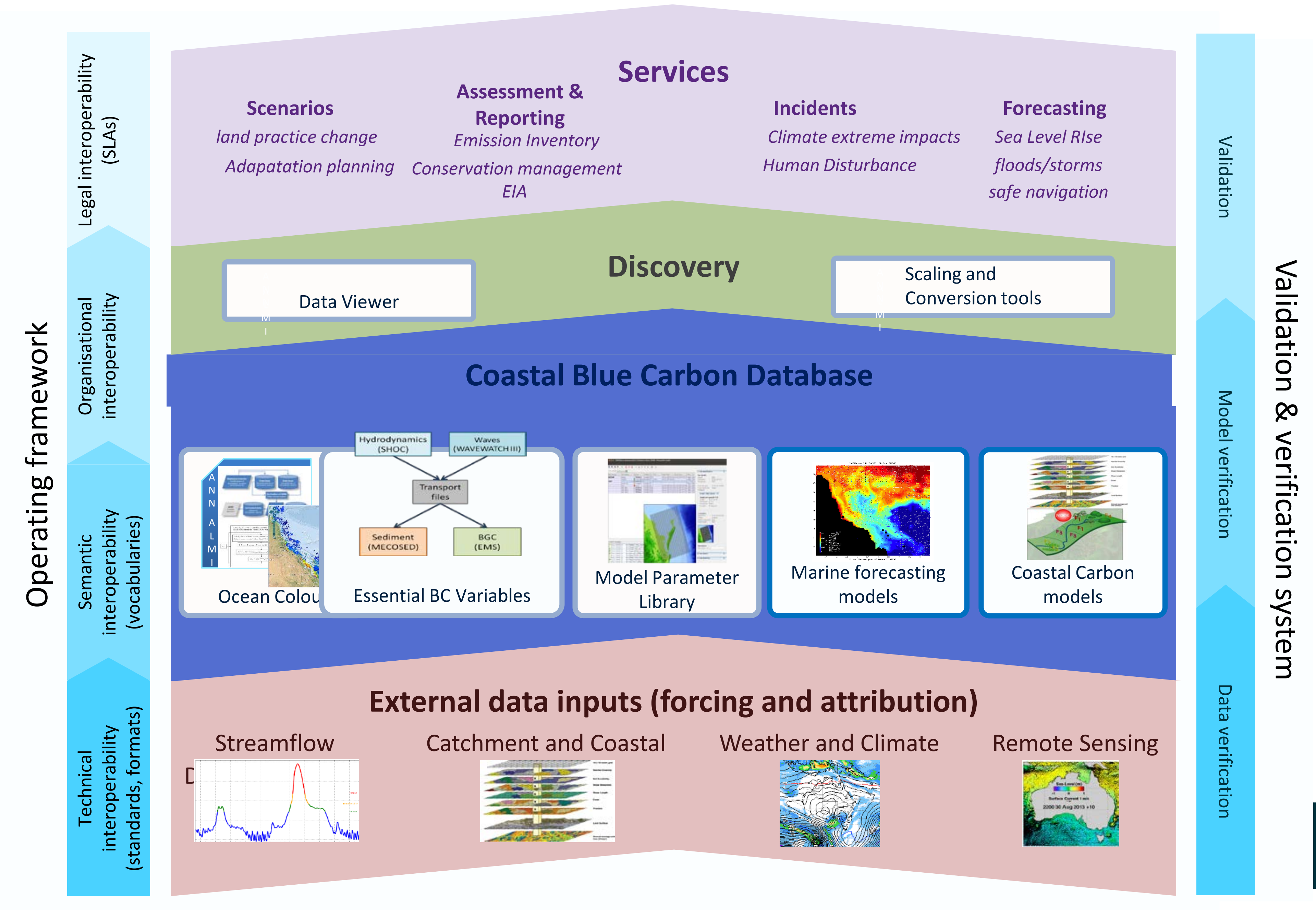
- Blue Carbon data can benefit from this work

Data interoperability & visualisation

- Data discovery and access to data services through a Data Integration and Brokering Layer.

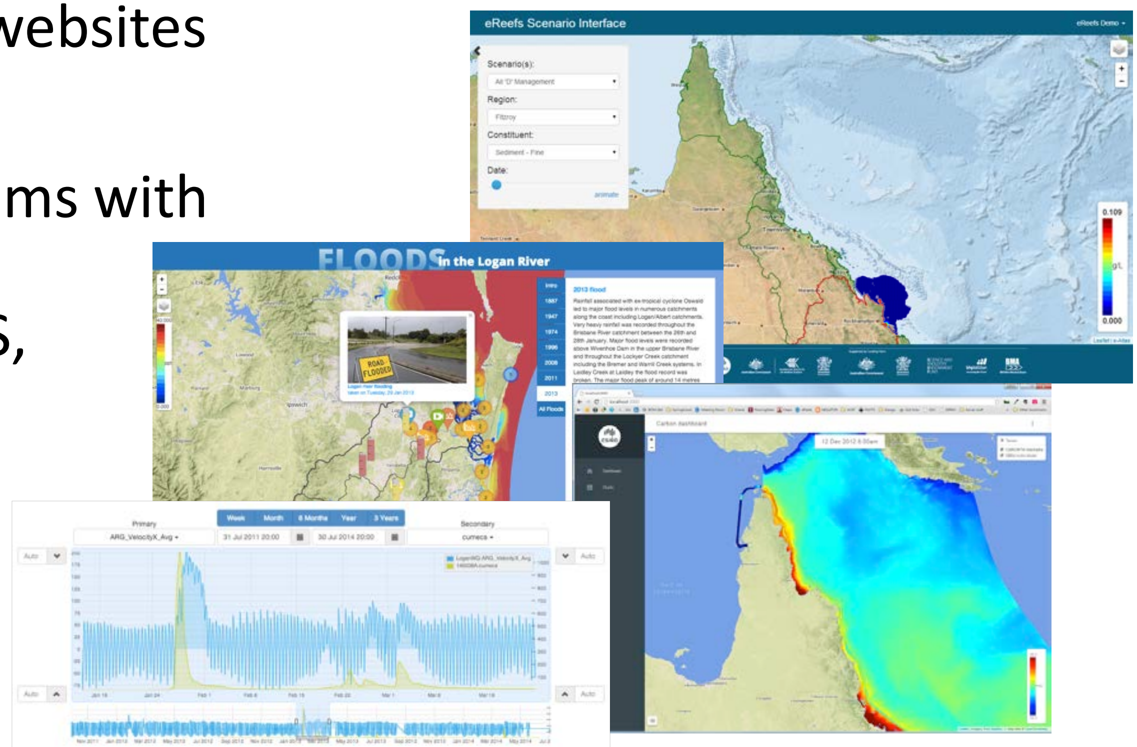


From Observations -to-Services to ….Sustainable systems



Visualising information

- Visualising data essential to move from data to knowledge
- Merging satellite, modelling, monitoring, spatial and other data in dynamic, service-driven websites
- Blending traditional systems with modern, “reactive” web technologies (e.g. NodeJS, MongoDB, Meteor)
- Backed by semantic data brokering and discovery services



Infrastructure Needs:
the Australian Coastal Ecosystems infrastructure
http://acef.tern.org.au

- A coastal information infrastructure] established under the Terrestrial Ecosystem Research Network (TERN)

- Implements common open source components – PostgreSQL, PostGIS, GeoServer, GeoNetwork, ERDDAP, THREDDS, MongoDB

- Built on the Australian research cloud (Nectar) with automated test and configuration systems (Jenkins, Nagios, more robust platform

Australian Coastal Ecosystems Facility

TERN
Terrestrial Ecosystem Research Network

nectar

- Hosted and managed by CSIRO as a national platform for all coastal information

Thinking about carbon data

- Cluster work has resulted in several types of data:
  - Small scale carbon content – individual samples
  - Broad scale carbon content – satellite remote sensing
  - Carbon processing rates and fluxes
  - Environmental monitoring – continuous & discrete

- Each of these need to be handled appropriately

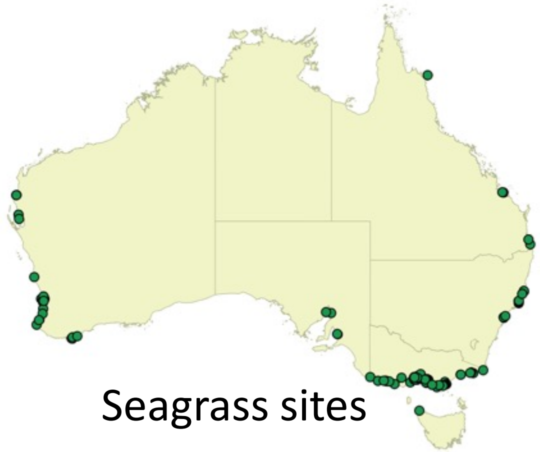
- There also need to be mechanisms to translate between data and parameters, and between different scales, ultimately to the national level.

Thinking about carbon data

- The national scale of the carbon cluster highlights the need to bring together data from numerous research across many institutions, all with their own data ownership needs

- Distributed systems and interoperability can play a part here, but transparency and open access is even more important

Saltmarsh sites



Seagrass sites

Mangrove sites

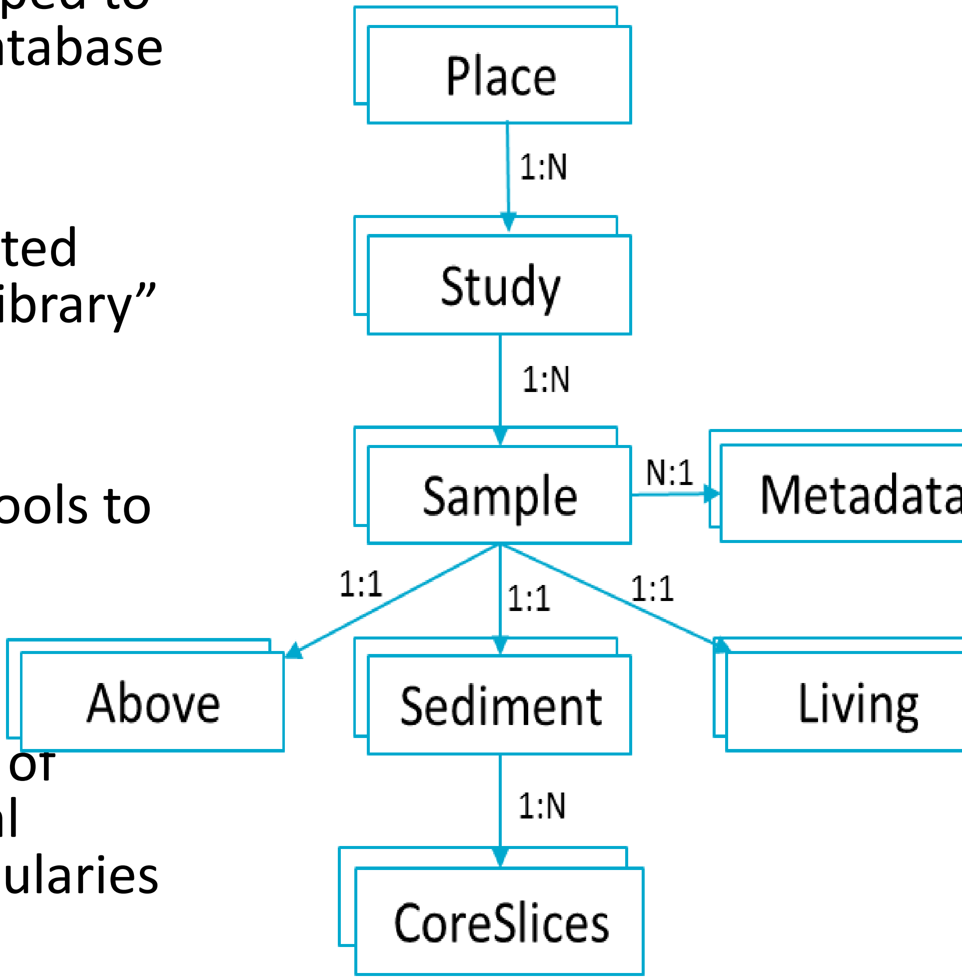
Carbon cluster database

- Carbon content data has been mapped to the proposed global blue carbon database fields, data to be loaded

- Rate and flux data has been integrated with a developmental “Parameter library” database

- Datasets, databases and end user tools to be hosted on national research infrastructure

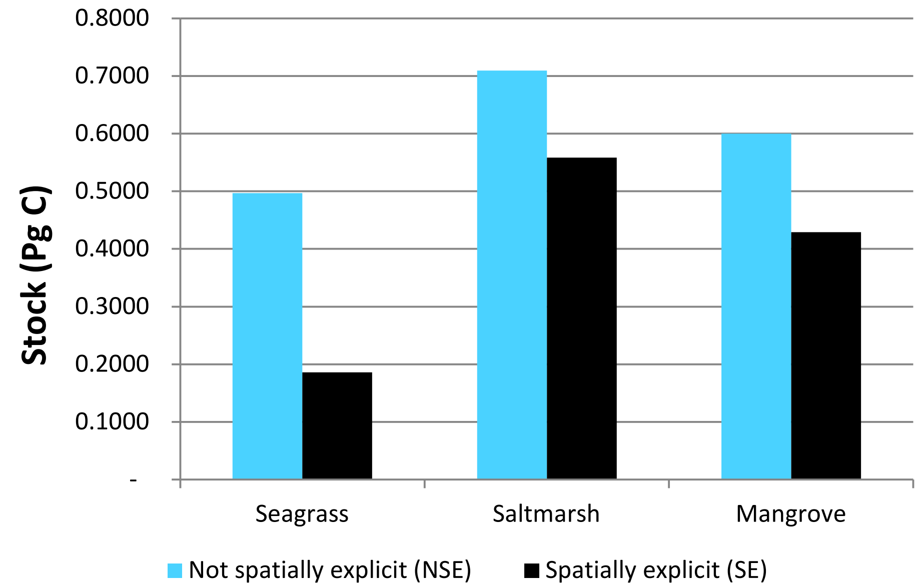
- Key work needed to finalize the list of fields, essential variables, additional attributes and to standardize vocabularies

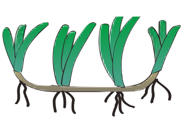
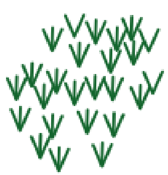
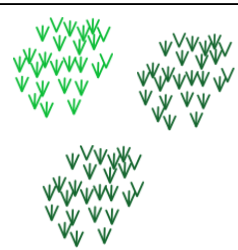
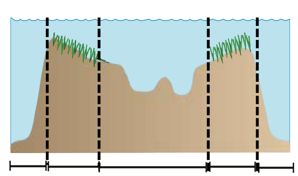
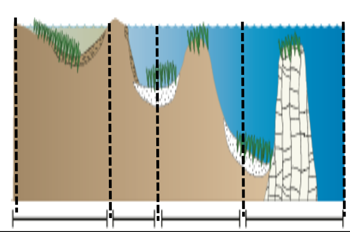
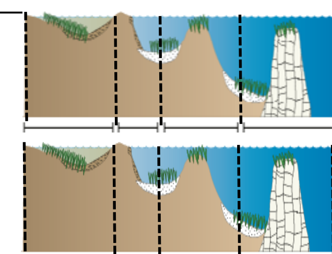


Going Global

Mangroves						
		Parameter	Level of information needed for a particular parameter			
			Minimum	Optimal	Ideal	Notes
Basic ecosystem descriptors						*Purpose: enable broader description of system*
Extent to which this parameter is important to measure	Minimum	**Area**	Area in hectares	% cover/ area (method)	distribuition maps or data	under the ideal, they will be able to validate existing extent data or upload their own
	Minimum	**Species**	Mono or mixed	Dominant species	Ranked list of species	
	Minimum	**Vegetation**	Presence/absence at point of sample	Qualitative estimate of density	Actual density (basal area) - Biomass (allometric equations used to estimate biomass)	
	Minimum	**General condition**	Impacted/Good conditions/Pristine	type of impact (dregde, boat, over fishing, polution, euthrophization etc);	Level of impact (method)	there are water classifications taken for environmtal purposses and
	Optimum	**Water sediment nutrient conditions**	oligotrophic/ euthrophic/ cultural euthroficated	mean value [N] , Soil and water mean value [P] soil and water	mean value [N] , methods, time of the measurement, soil and water mean value [P]	
	Optimum	**Substrate**	Classes: muddy / sandy / calcareous, etc		Grain size per slice	
	Optimum	**Bathymetry**	position in the intertidal zone - low, high	position relative to LAT or mean sea level (some fixed point) - method (unit)	Local bathimetry - digital elevation model with mangroves mapped onto the "bathimetry".	
	Optimum	**Temperature**	average air temperature at a meteorological station close to the site of measurement (regional)	Regional temperature (method)	Water/air temperature *in locu*	what is meant by regional? How is this defined?
	Optimum	**Salinity**	estuarine/marine	Salinity at site at some time (method)	Salinity *in locu measured at multiple time intervals (unit is PSU)*	

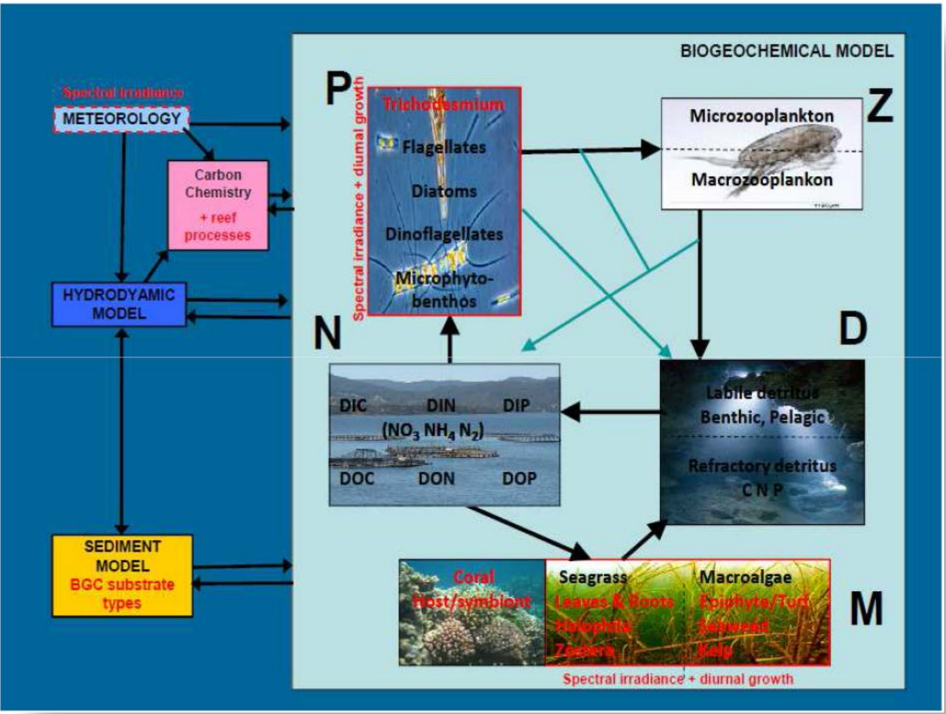
Scaling: from sites to regional habitats

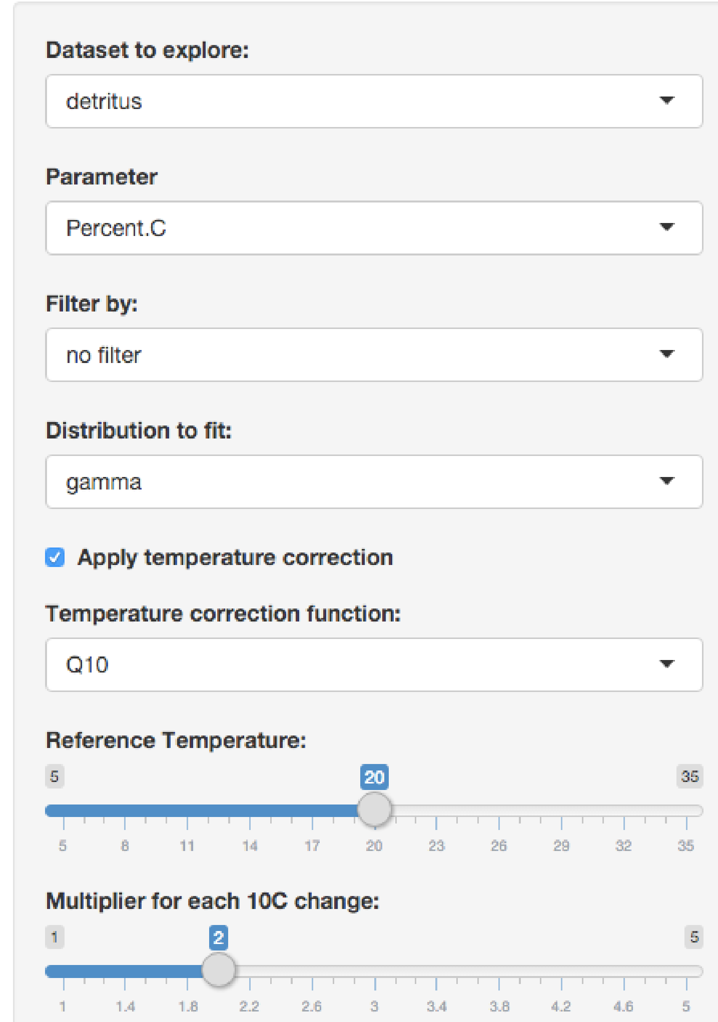


Organizational level					
Level 1	**Level 2a**	**Level 2b**	**Level 3**	**Level 4**	**Level 5**
Shoots (=<1m)	**Patch (m- 100m)**	**Patches (m - 100m)**	**Meadow (100m - km)**	**Regional meadows (km - 100 km)**	**Ecosystem (100 km - 1000 km)**
					
Source of variability: shoot	**Source of variability: shoot**	**Source of variability: shoot**	**Source of variability: shoot + environment (local)**	**Source of variability: shoot + environment (local + region)**	**Source of variability: shoot + environment (local + region + latitudinal)**

Parameter library database

Bio-geochemical model

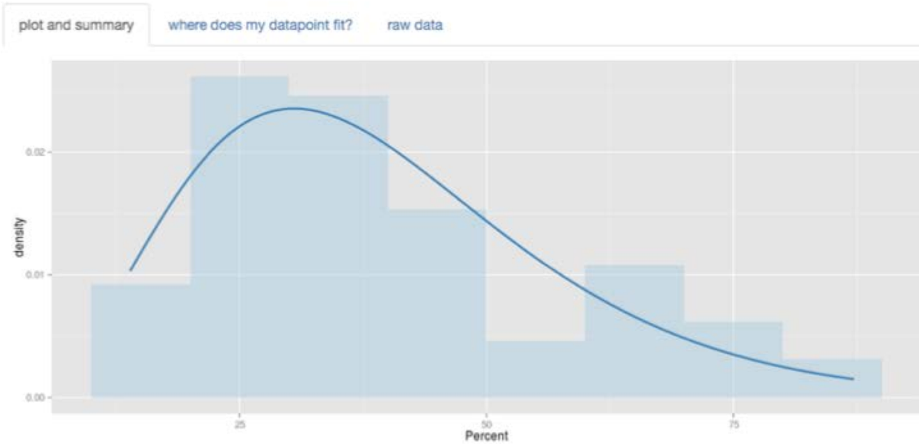




- Users choose parameters, geographic region, water type, distributions

Parameter library database

- Users choose parameters, geographic region, water type, distributions and other adjustments
- Matching data is retrieved and presented as a distribution
- Distribution statistics presented for direct use in modelling or other statistical procedures



show data histogram

Save plot to file

	mean	sd	units	distribution	shape	rate	n	aic
Percent.C	39.47	18.94	Percent	gamma	4.41	0.11	65	555.22

Parameter library database

- Raw data and references can also be accessed including DOIs or other links to source material
- Suits all similar data, not just carbon data

Detritus.source	Plant.type	Genus	Species	Fraction	Conditions	Percent.N	Percent.P	Percent.C	C.to.N	C.to.P	Decay rate (K)	Decay rate of labile fraction (K1)	Decay rate of refractory fraction (K2)	Bacterial.Growth.Rate..Single.Exponential.Rise.to.Max.	Metasource	Metasource.DOI	Source	D
Aquatic	Phytoplankton	Crysophyceae		Whole organism	Water	4.19	0.800	25.50	7.10	82.34	0.0360				Enriquez, S., Duarte, C. M., & Sand-Jensen, K. (1993). Patterns in decomposition rates among photosynthetic organisms: the importance of detritus C: N: P content.Oecologia,94(4), 457-471.	10.1007/BF00566960	Aizaki, M., Takamura, N., 1991. REGENERATION OF NUTRIENT AND DETRITUS FORMATION FROM AEROBIC DECOMPOSITION OF NATURAL PHYTOPLANKTON. Japanese Journal of Limnology 52(2) 83-94.	
Aquatic	Phytoplankton	Synechococcus		Whole organism	Water	6.08	0.850	29.27	5.62	88.96	0.0956				Enriquez, S., Duarte, C. M., & Sand-Jensen, K. (1993). Patterns in decomposition rates among photosynthetic organisms: the importance of detritus C: N: P content.Oecologia,94(4), 457-471.	10.1007/BF00566960	Biddanda, B.A., 1988. MICROBIAL AGGREGATION AND DEGRADATION OF PHYTOPLANKTON-DERIVED DETRITUS IN SEAWATER .2. MICROBIAL-METABOLISM. Marine Ecology Progress Series 42(1) 89-95.	10.3
Aquatic	Phytoplankton	Dunaliella		Whole organism	Water	4.52	0.983	45.40	11.73	119.29	0.0498				Enriquez, S., Duarte, C. M., & Sand-Jensen, K. (1993). Patterns in decomposition rates among photosynthetic organisms: the importance of detritus C: N: P content.Oecologia,94(4), 457-471.	10.1007/BF00566960	Biddanda, B.A., 1988. MICROBIAL AGGREGATION AND DEGRADATION OF PHYTOPLANKTON-DERIVED DETRITUS IN SEAWATER .2. MICROBIAL-METABOLISM. Marine Ecology Progress Series 42(1) 89-95.	10.3

Final thoughts: Carbon Cluster Database

- This work provides a structure for most types of blue carbon data including carbon content, rate & flux, remote sensing and others
- Existing frameworks, tools and infrastructure are available and will be used in the Australian context
- Appropriate Data scaling an gap-filling is essential for the global context
- Formal vocabularies and semantics can help ensure consistency and interoperability
- End users must be provided with modern, useful, usable tools

Final thoughts: Going Forward

- **Who and for what will it to be used for, now and in the future**?
  - Define user needs, products and services before defining structure
  - What are the essential B.C. Variables and standards required to deliver these products
- **Is it a database or an information system?**
  - *Information System* (IS) is any combination of information technology and people's activities using that technology to support operations, management, and decision-making.
  - *Database System*:- A database system is a term that is typically used to encapsulate the constructs of a data model, database Management system (DBMS) and database.
- **Does it need to be centralised, distributed or does it matter?**
  - Can *attribute* data (e.g Remote Accessed) be accessed from elsewhere
- **Developing the BCDB or BCIS**
  - Structure can be implemented on any number of platforms and software
  - Leverage and Reuse existing databases, standards, code, upload tools and DOIs
  - **Components include:** Central Relational Database, Catalogues and meta data Servers for geospatial (e.g. Geoserver) and remote sensing (e.g. THREDDS, ERDAPP

Good Sites to explore

Data Quality Assurance SOPS

- Quality Assurance of Real Time Ocean Data(QARTOD)
- http://www.ioos.noaa.gov/qartod/welcome.html

Quality Assured Carbon Data

- Surface Ocean CO2 Atlas (SOCAT)
- http://www.socat.info/upload.html

Recognizing your contribution

- Datacite
- https://www.datacite.org/about-datacite/members

Interoperability

- Ocean Data Interoperability Program (ODIP)
- https://www.datacite.org/about-datacite/members

The 4th International Symposium on the Ocean in a High-CO2 World | Hotel Grand Chancellor | 3-6 May 2016 | Hobart, Tasmania, Australia

The Ocean in a High-CO_2 World

Ocean Acidification

An international science symposium series

Hobart, Tasmania, 3-6 May, 2016

http://www.highco2-iv.org

GOA-ON
Global Ocean Acidification Observing Network

3rd Global Ocean Acidification Observing Network (GOA-ON) Workshop, 8-10 May 2016, Hobart

http://www.goa-on.org

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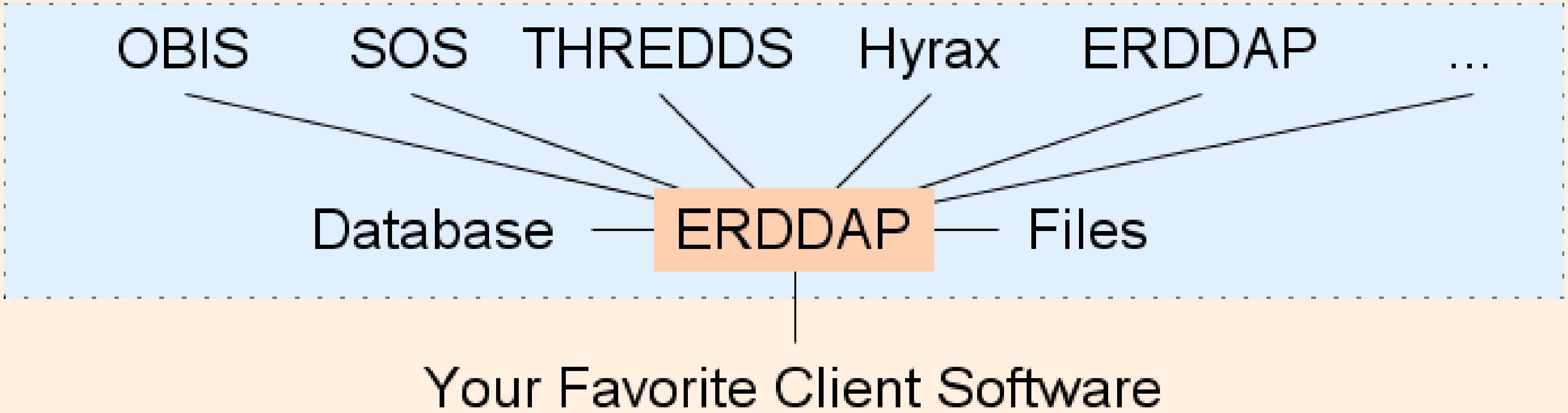
BLUE PLANET Oceans and Society | NOAA | IOOS | GOOS Global Ocean Observing System | UNESCO United Nations Educational, Scientific and Cultural Organization | Intergovernmental Oceanographic Commission | IAEA | Ocean Acidification International Coordination Centre OA-ICC | International Ocean Carbon Coordination Project IOCCP | CSIRO

ERDDAP

is a middleman data server designed to help you get data from any data source into your favorite client software.



Try it: coastwatch.pfeg.noaa.gov/erddap

Bob Simons <bob.simons@noaa.gov>
NOAA NMFS SWFSC ERD

Finding data and downloading it into your favorite client software is too hard!

1. There is no unified search system to help you find datasets.

   Different datasets are available at different web sites.

2. Different data servers use different request protocols.

   (XML, SOAP+XML, OPeNDAP, WCS, WFS, SOS, an HTML form, ... !)

3. Different data servers return data in different formats

   (XML, SOAP+XML, DAP binary, ASCII text, HDF 4, HDF 5, NetCDF, ... !)

   and it usually isn't the common file format that you want.

   (.html table, ESRI .asc, .kml, .mat, .nc, .csv, .tsv, .json, .xhtml, ... !)

4. Different datasets have time formatted in different ways.

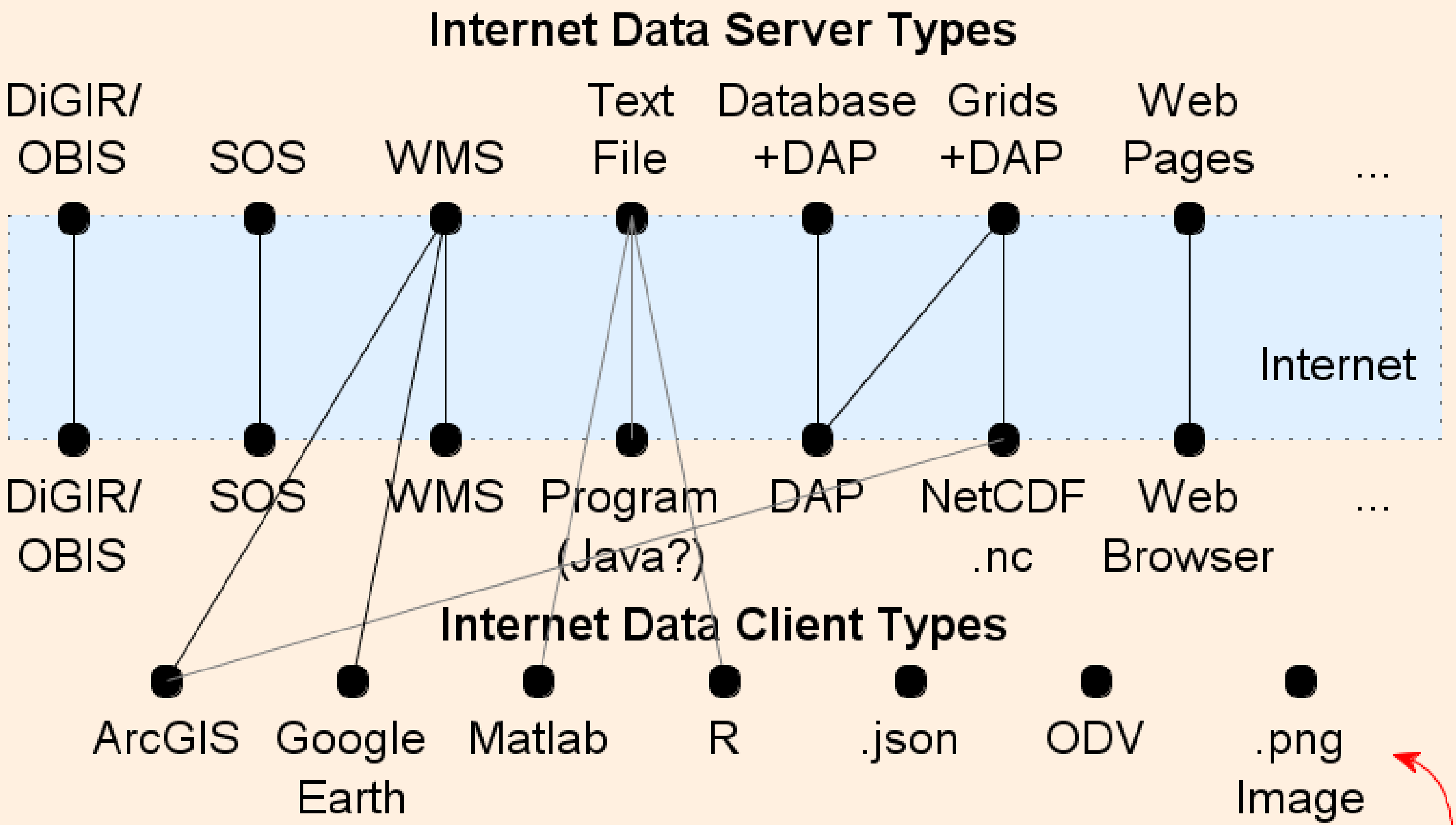
   ("Jan 2, 1985", "02-JAN-1985", "1/2/85", "2/1/85", "1985-01-02", Year + DayOfYear, "seconds since 1988-01-01", "days since 1-1-1", ... !)

   That makes it hard to compare data from different datasets.

5. Most datasets have insufficient metadata.

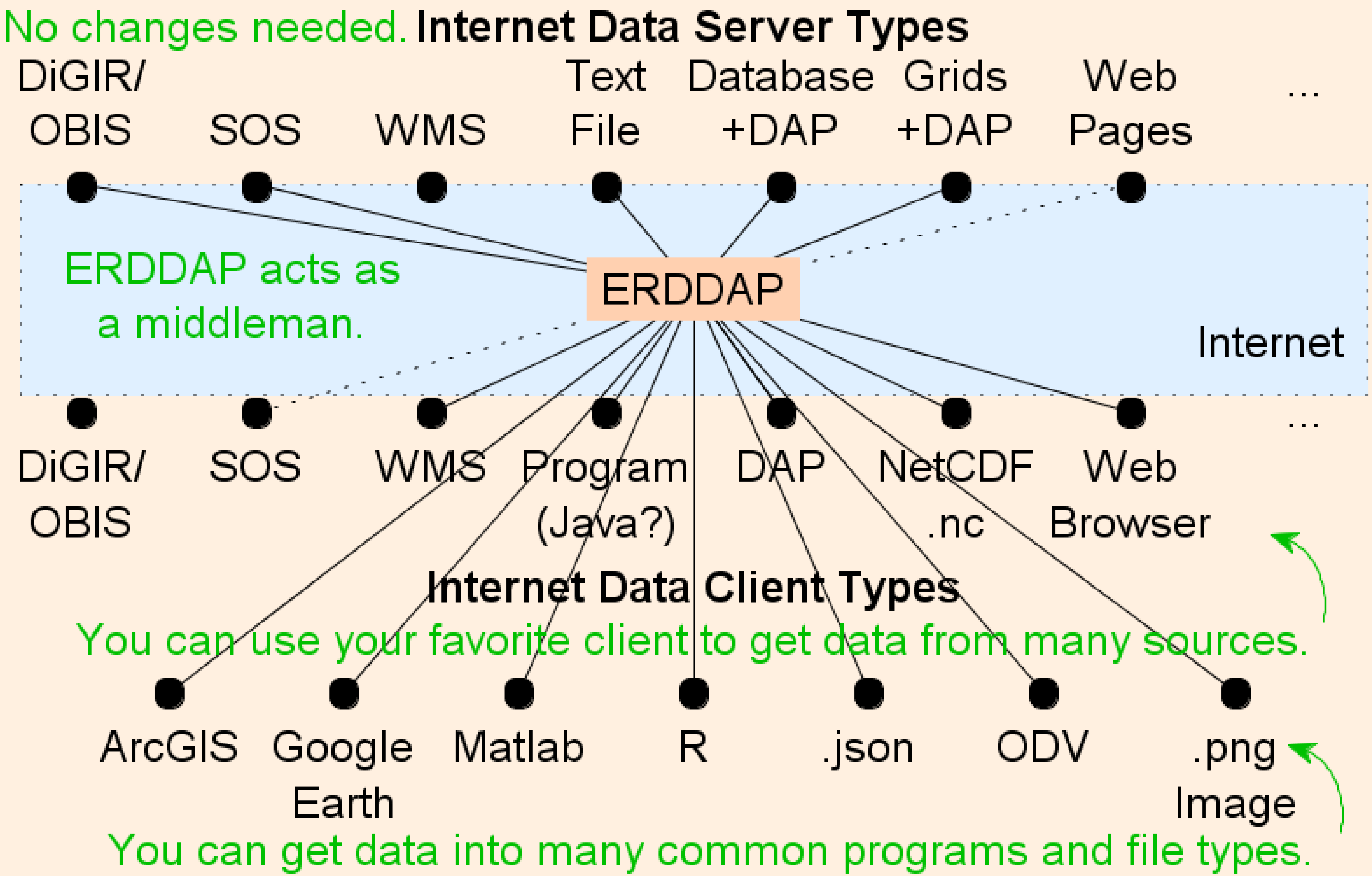
   That makes it hard to understand the data.

Different communities use different data servers. Each is fine by itself. But they all work differently!



So there's no easy way to get data into other programs or file types.

ERDDAP solves those problems by acting as a middleman.



ERDDAP offers a unified way to search for datasets of interest.

Since ERDDAP is a middleman, it acts as if it has all of the datasets from all of the remote data servers. A search in ERDDAP for datasets of interest searches the metadata of all of those datasets.

- ERDDAP offers Google-like full-text search.
  For example: sea surface temperature
  Full-text search is also available via an OpenSearch service.

- ERDDAP offers category (faceted) search.
  The ERDDAP administrator specifies the categories.
  ERDDAP generates the list of options from the datasets' metadata.
  For example: standard_name = sea_surface_temperature

- ERDDAP offers advanced search.
  Advanced search combines full-text search, faceted search, and searches by latitude, longitude, and time range.

ERDDAP offers a consistent way to request data.

ERDDAP accepts OPeNDAP and WMS requests (*SOS* and WCS soon) for data from any dataset. ERDDAP then translates those requests into the request format that the remote data server uses.

(HTTP GET, XML, SOAP+XML, DAP, WCS, WFS, SOS, an HTML form, ...)

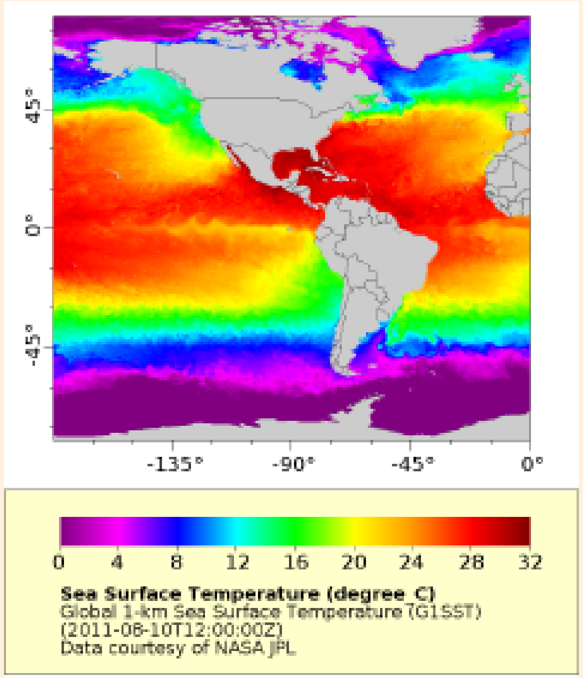
ERDDAP lets you specify the file format for the returned data.

Each remote data server returns the data in a different format.
(XML, SOAP+XML, DAP binary, ASCII text, HDF 4, HDF 5, NetCDF, ...)
ERDDAP reformats the data into the file format that you requested.
(.html table, ESRI .asc, .kml, .mat, .nc, .csv, .tsv, .json, .xhtml, ...)
No more wasting your time converting one file format to another.

Gridded data, graphs, and maps can be requested via specially formed, RESTful, OPeNDAP URLs.

The URL specifies everything: dataset, response file type, subset:
http://coastwatch.pfeg.noaa.gov/erddap/griddap/jplG1SST.html
?sst[(2011-08-10T12:00:00)][(-80):100:(80)][(-180):100:(0)]

- Special file types: .html (Data Access Form), .graph (graphical form), .fgdc, .iso19115
- Data file types: .asc, .csv, .das, .dds, .dods, .esriAscii, .htmlTable, .json, .mat, .nc, .ncHeader, .odvTxt, .tsv, .xhtml
- Image file types: .geotif, .kml, .smallPdf, .pdf, .largePdf, .smallPng, .png, .largePng, .transparentPng
- If time is `last`, you will get the latest data.

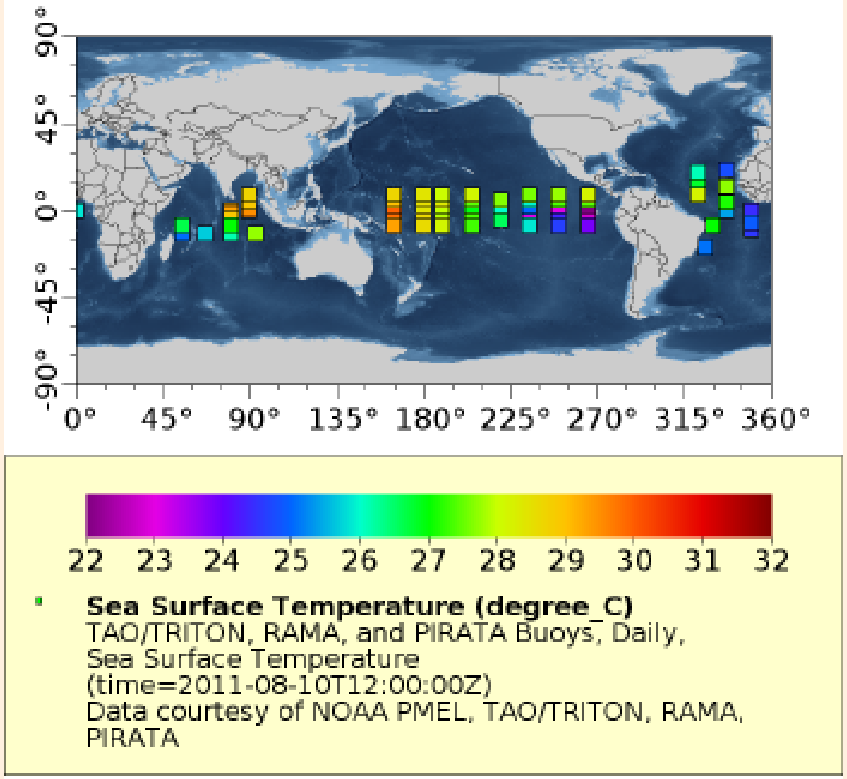


Tabular data, graphs, and maps can be requested via specially formed, RESTful, OPeNDAP URLs.

The URL specifies everything: dataset, response file type, subset:

http://coastwatch.pfeg.noaa.gov/erddap/tabledap/pmelTaoDySst.html
?longitude,latitude,T_25,time&time=2011-08-10T12:00:00

- **Special file types:** .html (Data Access Form), .graph (graphical form), .subset (for enumerated variables), .fgdc, .iso19115
- **Data file types:** .asc, .csv, .das, .dds, .dods, .esriCsv, .geoJson, .htmlTable, .json, .mat, .nc, .ncCF, .ncCFMA, .ncHeader, .odvTxt, .tsv, .xhtml
- **Image file types:** .kml, .smallPdf, .pdf, .largePdf, .smallPng, .png, .largePng, .transparentPng



ERDDAP standardizes the format of time data.

ERDDAP reformats date+time data from the source data format ("Jan 2, 1985", "02-JAN-1985", "1/2/85", "2/1/85", "1985-01-02", Year+DayOfYear+TimeOfDay, "seconds since 1970-01-01T00:00:00Z", "months since 1-1-1", ...)
into

- A string in the ISO 8601:2004(E) format (e.g., 2012-11-28T16:40:00Z), or
- The number of "seconds since 1970-01-01T00:00:00Z" (Unix Time)

depending on the requested file format. The time zone is always Zulu (UTC, GMT). The standardized format makes data from different datasets easy to compare.

ERDDAP also has a web page and a web service that can convert string times to/from numeric times:
http://coastwatch.pfeg.noaa.gov/erddap/convert/time.html

ERDDAP encourages the administrator to improve each dataset's metadata.

Metadata helps the user understand the dataset.
(What is this dataset? Where is it from? What are the units? How can I find out more?)
But the source dataset's metadata is often pathetically insufficient.
(Why? Written for the research group, maybe for the community, not for others. Now vs. in a year.)

ERDDAP:

- Encourages administrators to add and modify metadata.
- Requires important metadata: title, summary, infoUrl, history.
- Displays the metadata in many places (e.g., below forms and in pop-ups).
- Supports metadata standards, especially:
  - Climate and Forecast (CF)
  - Unidata's Attribute Conventions for Dataset Discovery (ACDD)
- Automatically generates FGDC and ISO 19115 metadata.
- Offers a service to convert UDUNITS to/from UCUM:
  http://coastwatch.pfeg.noaa.gov/erddap/convert/units.html

ERDDAP users don't need a new plug-in or library.

Plug-ins and libraries (client-side solutions) can be great.

Sometimes they are the best or only solution.

However, they have disadvantages.

- Some users are reluctant to install them.
- Some users don't have permission to install any software.
- Some users will have difficulty installing them.
- Plug-ins may break when the application is updated.
- If there is a new version of the plug-in (e.g., with a bug fix),
  it is impossible to get all users to update.
  You probably don't even know who they are.

ERDDAP is a server-side solution.

It doesn't have these problems.

Users can keep using their favorite client software.

One administrator updates ERDDAP and
the changes apply to all users, immediately.

ERDDAP's web applications are built on ERDDAP's web services.

Web Applications (a web page with a form) are great for humans with a browser, but usually aren't suitable for big tasks. Imagine having to make 1000 requests by hand!

RESTful Web Services (where a single request URL using a standard protocol like OPeNDAP specifies an entire request) are easy to automate with computer programs and scripts.

It's easy to build web applications on top of web services.
So that's what ERDDAP does.
Everything in ERDDAP has a web application (human-friendly) which uses an underlying web service (script-friendly).
You can use either one.
It's easy to build other web services on top of web services.

For Data Providers: How does ERDDAP relate to other data servers?

If you already have a data server or web pages, keep them, but consider installing ERDDAP as an alternative.

ERDDAP can get data from your data server (especially THREDDS and HYRAX)
or from the same database or source files.

If you don't have a data server, consider using ERDDAP.

ERDDAP is free, reusable software.

Spending a few hours to install ERDDAP saves you months or years of effort
to make your own system (which probably won't be as good). What a deal!

ERDDAP lets you offer additional features:

- Catalog search services (full text search and faceted search)
- OPeNDAP and WMS services
- Users can download their data in many common file types (generated on-the-fly).
  Don't make users waste their time converting files from one format to another!
  Users don't need plugins or libraries.
- Users can generate customizable maps and graphs (generated on-the-fly).
- ERDDAP handles gridded data **and** in-situ / tabular data.

Summary:

Acting as a middleman allows ERDDAP to

- **Provide a unified way for users to search for datasets.**
  Via full-text search, category-based (faceted) browsing, or advanced search.
- **Offer a standard way to request data from any dataset.**
  Via web applications - web pages with forms for humans.
  Via web services - one RESTful URL specifies the entire request.
- **Let users specify the response file format.**
  Data file formats for your favorite application.
  Image file formats for custom graphs and maps.
- **Standardize the format of time data.**
  As strings - ISO 8601:2004(E), e.g., 2011-08-03T20:00:00Z .
  As numbers - seconds since 1970-01-01T00:00:00Z .
- **Improve each dataset's metadata.**
  So users can understand the data.

I. Identifying policy/project needs that are consistent with a science-focused blue carbon data base

Scales

International/National

1) REDD
    a) Attribution (human/natural drivers)
    b) For restoration projects (C mitigation potential)
2) National
    a) Inventory –
        i) defining robust/minimum sample sizes and experimental approach
        ii) public land management – how management practices influence ecosystem services including C mitigation potential
3) State/Regional
4) Site

Elements

1) Governance
    a) Institutional arrangements
2) Management
    a) How to identify and manage data types of different quality, adequacy and suitability/applicability?
        i) Tiered data system based on format/peer-review
            (1) Agency databases/datasets → ERDPP
            (2) Peer-reviewed publications → standard data input protocol and user interface developed to assess flags when its not met
            (3) Grey literature or unpublished data → standard data input protocol and user interface developed to assess flags when its not met AND ??
                (a) Ranking system that forms the basis for assessment, based on standard metadata information
                (b) Assign a DOI
            (4) New data collection
                (a) Standard methodological protocols/SOPs
            (5) What is the minimum standard for data?
3) Metadata

Data output format geared toward different applications

1) Technical data outputs
    a) Features: maximum flexibility of use
2) Summary or graphical data outputs
    a) Features: quick access, aggregated format

User interfaces

1) Format/protocol for technical data inputs/outputs
2) Format/protocol for summary data inputs/outputs

Products

1) Flat data files that can be downloaded for various parameters
2) Validation
3) Parameter library with best estimates at a regional basis
4) Data user interface

Relevant initiatives and databases/datasets

Databases/datasets:
USAID climate data platform
Agency databases

Initiatives:
GEO network & GFOI
CEOS Network (USGS incoming chair)
JAXA network
WRI - Global Forest watch
Global mangrove watch
GEOBON, EUBON data working groups

II. Policy/project data needs that are consistent with a science-focused blue carbon data base

What are the types of policies/projects?

1. REDD
    a. Attribution (human/natural drivers)
    b. For restoration projects (C mitigation potential)
    c.
2. Inventory –
    a. defining robust/minimum sample sizes and experimental approach

3. Public land management – how management practices influence ecosystem services including C mitigation potential

4. Mitigation
    a. National environmental policy act

5. Mitigation/adaptation planning and management decisions

6. Coastal management plans and prioritization of projects/sites

7. Identifying funding needs

8. Transboundaries

9. Repository of regionally-appropriate data – SDGs, ACHIE (Japan) targets, Ramsar, Blue economy initiative (sustainable economies and services)

10. High level communication products – summary data

11. Conservation planning (land acquisition piece of mitigation/adaptation)

12. C offset projects: (1) C markets (2) voluntary offsets

What are the data types and what are the minimum requirements?

What are the data types:

Previous list from the IBCWG &

1. % cover of dominant ecosystem
2. parameters that are used to estimate stocks and fluxes i.e.
    a. Aboveground C stock > biomass > height, DBH, density; species; allometric model; vertical stratum
    b. Fluxes and variables needed to calculate them
3. attribute data:
    a. degree of degradation
    b. context – adjacency
    c. protection level
    d.

Other data types and considerations:

1. Attribute definitions and how they map to specific policy uses i.e. forest type, degree of degradation, context, etc
2. Categorization based on the stock/flux that are brought forward with queries
3. Data products that support land use change
    a. Validation for remote sensing products
4. Categorization based on standard attributes that define context

Defined minimum requirements and means to flag them when they are not met:

1. Metadata parameters and set of guidance documents to form the basis to identify and define these attributes
2. Estimate of uncertainty if data are aggregated (Mean and variance or 5 replicates that belong to a site)

3. Automated flagging when those parameters don't exist
4. Temporal frequency, etc, etc

Breakout 2-Science

Database: Recommendations for Governance and Management

1. *How can we collaborate and interact with existing relevant databases and datasets?*
2. *What management structures will make the database most accessible?*
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5. *What level of QA/QC is needed?*
6. *What resources (budget) will be required?*

Limited Resources

- Tier 1: Absolutely necessary
- Tier 2: Effective use of resources…great science
- Tier 3: In an ideal world…

Goals of the Information System

- Science Questions
  - What can we do together that we can't do alone?
  - Holistic Understanding
    - Spatial and temporal variability
  - Amount of C at risk so carbon accounting modeling possible
  - Change detection
  - Synthesized data
  - Models
    - Empirical, process, neural nets, spatial, numerical
    - forecasting
  - Improve data analysis techniques
  - Land-ocean flux
- Principles
  - Global
  - Inclusion/open
  - Registration/citation/invitation to co-author/creative commons
  - Bi-directional
  - Flexible/with guidance
  - Future thinking
  - Simpler is better
  - Crediibility

- Stakeholders
  - Scientists, Science Agencies
  - End users for policy, projects
  - Gather needs from users
  - Consultants & NGOs
  - Technical staff
  - Climate Negotiators
  - Users of visualizatizations (Educators)
  - Carbon Market
  - IPCC
  - Scientists/assessment folks/end-users
- Products
  - Global budgets, GHG inventories, SOCCR
  - National level inventories
  - Vulnerability of C fluxes maps (to SLR, climate change, human activities)
  - Files, value-added products, bi-directional products/forecast models
  - Reduced uncertainty
  - Definitions

How can we collaborate and interact with existing relevant databases and datasets?

- Lessons learned?
  - Needs to be credible (need people)
  - Network oversight
  - Way to ingest metadata
- Why would someone submit data?
  - Peer pressure
  - Promise of publication (synthesis papers)
  - Visibility
  - Easy to fulfill federal data requirements
- Pointers to data in other databases

What management structures will make the database most accessible?

- Need data curators/managers
- User/contributor guidance
- Clearly communicated tiered system of QA/QC
- Who is in charge?
- Who can host?
  - NERRS, NOAA, USGS, NASA, DOE, international organization (DataONE), UMich (soil database)
  - Mistake to have agency host?
  - Initialization and maintenance
  - Marketing to potential host/funder/program manager

What is the data use policy for the database?

- Creative Commons (default)
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- Grace period-restricted data?
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How do we ensure database is international in scope and what challenges are involved?

- Understand cultural differences
- Workshops/trianing rotate to different countries
- Link to other international networks
- Engage to network←→database
- Include initial synthesis projects
  - Publication on terms
  - Best practices
  - Identify new synthesis papers
- Use NGOs
- International funding source
- Mirror sites?

What level of QA/QC is needed?

What resources (budget) will be required?

Database Design and Data Standards

1. *What different data types are necessary?*
2. *What minimum requirements of the data to support the database objectives?*
3. *How would you bridge differences in data types to support the database objectives?*
4. *How would you query the database? What combinations of data, formats and metadata are useful?*

Our goal for this SBC Workshop

	Tuesday	Wednesday	Thursday
I	Introductions	Review Presentations: Database Examples	Presentation to CCIWG Web/Audio discussion
Break			
II	Introduction from Steering committee	Breakout Group: Database Governance	Final decisions
Lunch			Adjourn meeting
III	Breakout Group: Network: Need&Structure	Breakout Group: Database Design	
Break			
IV	Results of Breakout Groups	Results of Breakout Groups	

Breakout 2-Science

Database: Recommendations for Governance and Management

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Science Breakout Day 2

- Stakeholders
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Science Breakout Day 2

What level of QA/QC is needed?

- Quartod
- **Levels of quality**
  - Flexible, levels can change over time
- Questionnaire as part of Metadata
- Vs. “no QA/QC
- Comparison with collective data (1 SD)
- Certification vs. **transparency**
- “flags” metadata
- Revisit QA/QC after initialization phase
- Publish Best Practices for establishing best data
  - Checklist
- Don’t automatically throw out discrepant data
- Users **comments/wiki**
- Accompanied with accuracy data
- Avoid judgement of data
- Protocol for minimum metadata to be accepted
- Committee (and personnel) to **oversee** process of QA/QC and revisit policies

What resources (budget) will be required?

- 2 people of QA
- What is data $330k to $70k/year
- 0.3-1.5 FTE for archiving DAC
- NERRS-CDMO ($300k maintenance)
- Each LTER ($100k/year-1 FTE)
- Ameriflux-4 FTEs (100 active towers)
- Community peer review
- **Start simple (just C stock)?**
- **Maintenance (1 admin for network + website)**
- **Initialization: 3-4 FTE for 2 years**
- + Network activities (workshops)
- **Fund synthesis Projects concurrently**
- E.g. Sessync
- Data Visualization.

Database Design and Data Standards

1. *What different data types are necessary?*
2. *What are the minimum requirements of the data to support the database objectives?* [see IBCSWG list]
3. *How would you bridge differences in data types to support the database objectives?* [spatial scale, temporal frequency, resolution…]
4. *How would you query the database? What combinations of data, formats and metadata are useful?*

What different data types are necessary?

- Stocks (incorporate PIC)
- Flux data (soil, air & water)
- Spatial extent of ecosystem / patch
  - Locations/spatial replication
- Relative elevation / datum
- Climate / environmental data**
    - Site data: vegetation / ancillary
- Raw data preferred: avg. vs. replicates?
  - Separate datasets
  - Need to identify who is responsible
- Dated cores
- Historical data (including maps)**
- Metadata
- Code for derived data (algorithm)

What minimum requirements of the data to support the database objectives?

- Locations (lat/long) – notes on accuracy critical
- Time
- Check with Ameriflux approach
- stocks, changes, fluxes   and many 2ndry datasets (decomp rates, etc…)
- Experimental data useful, as well as restoration sites
- Chronosequence

How would you bridge differences in data types to support the database objectives?

- Explicit metadata – should identify appropriate scale
- Identify preferred scale/level of resolution
- Be as broad as possible
- Important to consider for derived products

How would you query the database? What combos of data, formats and metadata are useful?

- Climate zone, geomorphic setting
- Vegetation
- Much relates to metadata with standardized vocabulary – use forms with choices
- Soil type/order?
- Intelligent system to identify comparable sites
- Hierarchy of locations
- Value added / derived products

Establishing a Global Science and Data Network for Coastal Blue Carbon (SBC)

USGS Headquarters - Western Region
Menlo Park, California
12-14 January 2016

Why a Global Science and Data Network for Coastal Blue Carbon?

Science:

-Leadership to define and raise the caliber of blue C science

-Access to global high quality data and research

-Improve basic & applied science on C & GHG cycling in coasts

-Access to science users to understand needs

Policy:

-Generate large scale accounting of C emissions and sequestration

-Need data to support Blue C inclusion in policy and regulation

-Need to access topic experts

Conservation Projects:

-Quantify current and future carbon in project areas

-Need to access topic experts

Broad Spectrum of Users and Needs

Basic Science & Synthesis

Regional Carbon Accounting

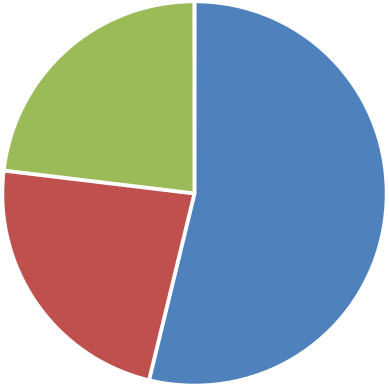
Support Climate-Related Finance of Conservation Projects

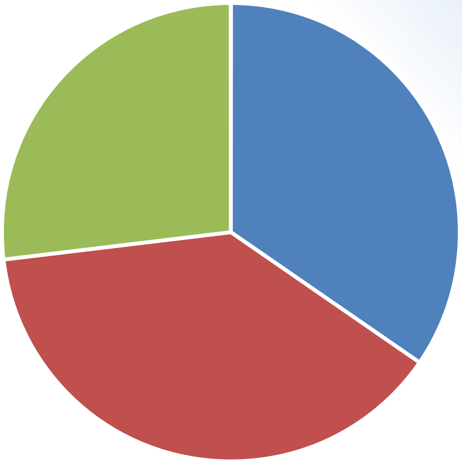
Applied Science & Models

Coastal Policy and Regulation Enforcement

Carbon Market Projects

Workshop – 12-14 January 2016

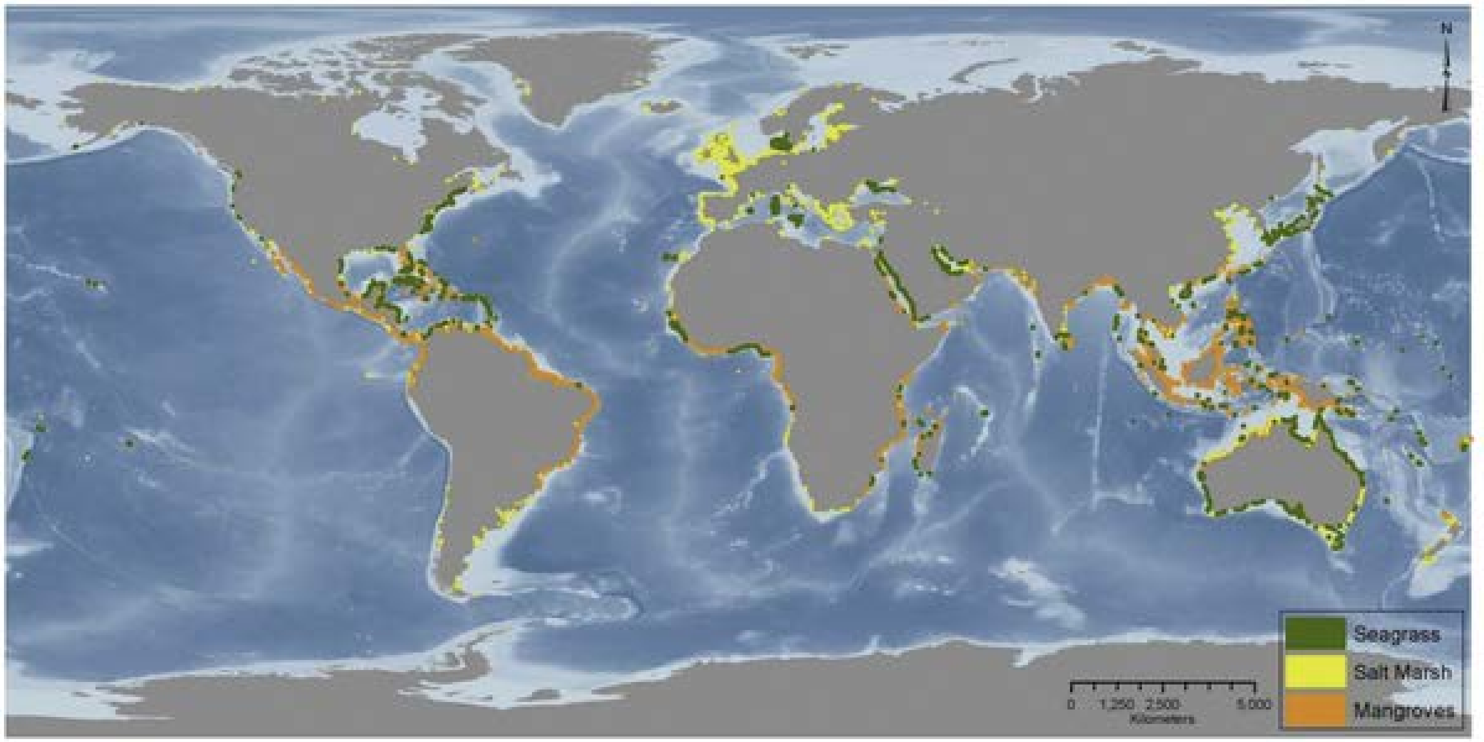




Motivation for Global Science and Data Network for Coastal Blue Carbon

Across spectrum need for:

a. Confidence in accurate and accessible blue carbon data
b. Global data coverage
c. An inclusive network of stakeholders
d. Leadership and definition of the field of blue carbon science



Vision for SBC Network and Database

Goal: Establish a Global Science and Data Network for Coastal Blue Carbon (SBC), to support carbon and GHG cycle science in coastal ecosystems.

- Improve science on carbon and GHG cycling in vegetated coastal ecosystems
  - Basic science
  - Applied science that addresses policy
- Identify priority research gaps
- Provide a quality-assured coastal carbon and GHG database
- Build global capacity to collect and interpret high quality coastal carbon data

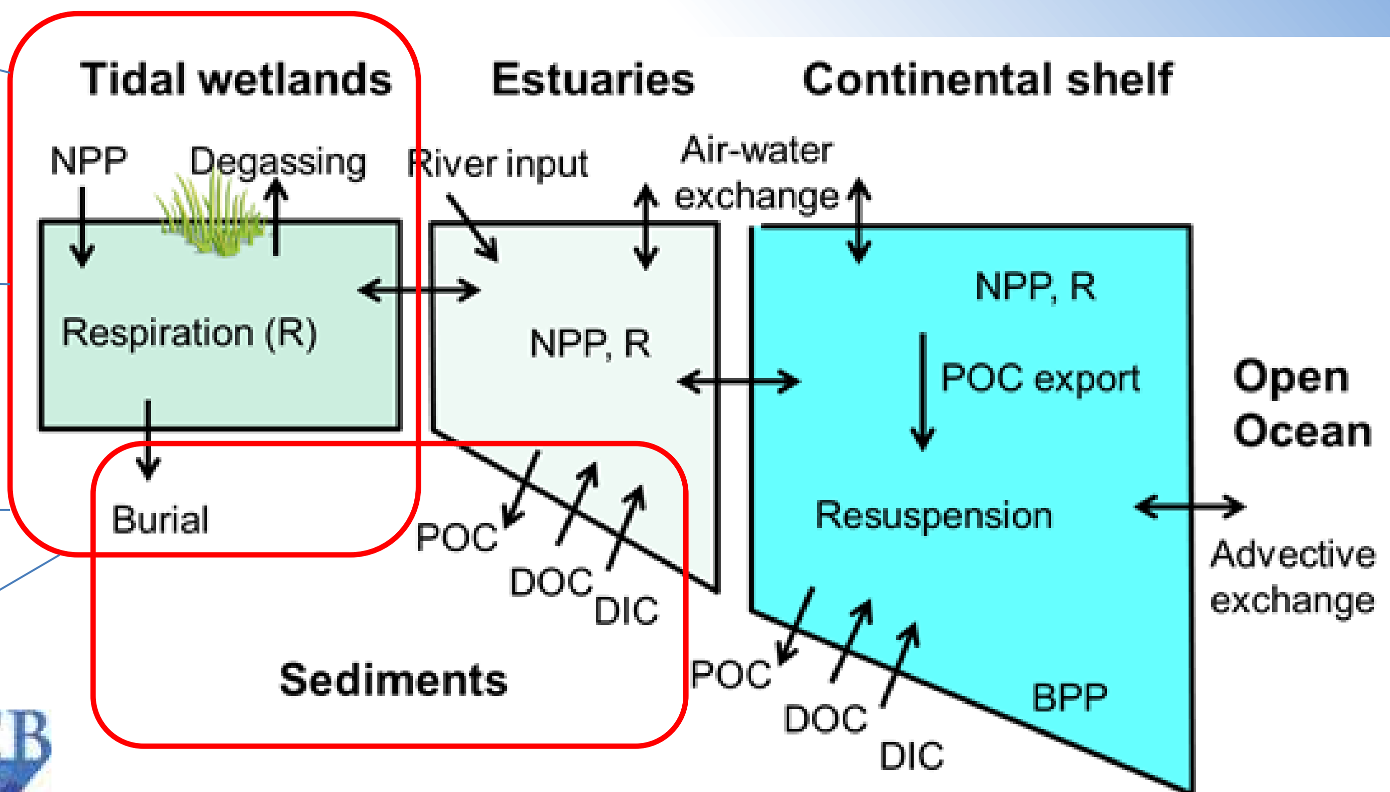
Why focus on Blue Carbon Habitats "only"?

Marsh

Mangrove

Seagrass

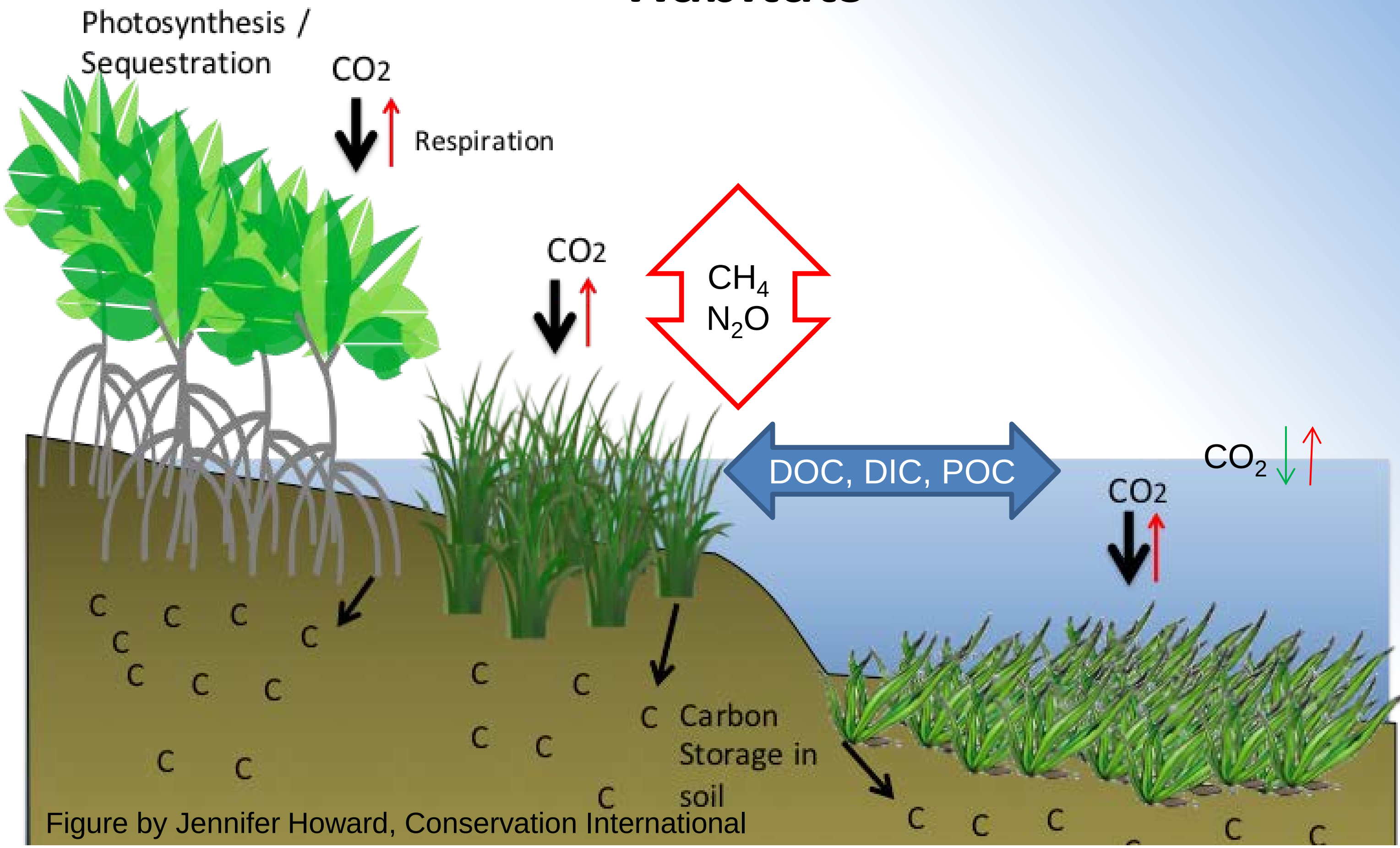
Other



North American Carbon Program

subset of habitats in
Coastal CARbon Synthesis

Carbon and GHG Fluxes and Processes in Blue Carbon Habitats



- Atmospheric Flux (Eddy Covariance, Chambers)
- Hydrologic (Lateral) Flux (dissolved and particulate, inorganic and organic)
- Vegetation Pools (Species, Mapping, Biomass above and belowground)
- Soil Pools (Depth, Accretion/Erosion/Oxidation, Carbon density, Provenance)

Management and Policy Needs

Priority Agenda

Enhancing the Climate Resilience

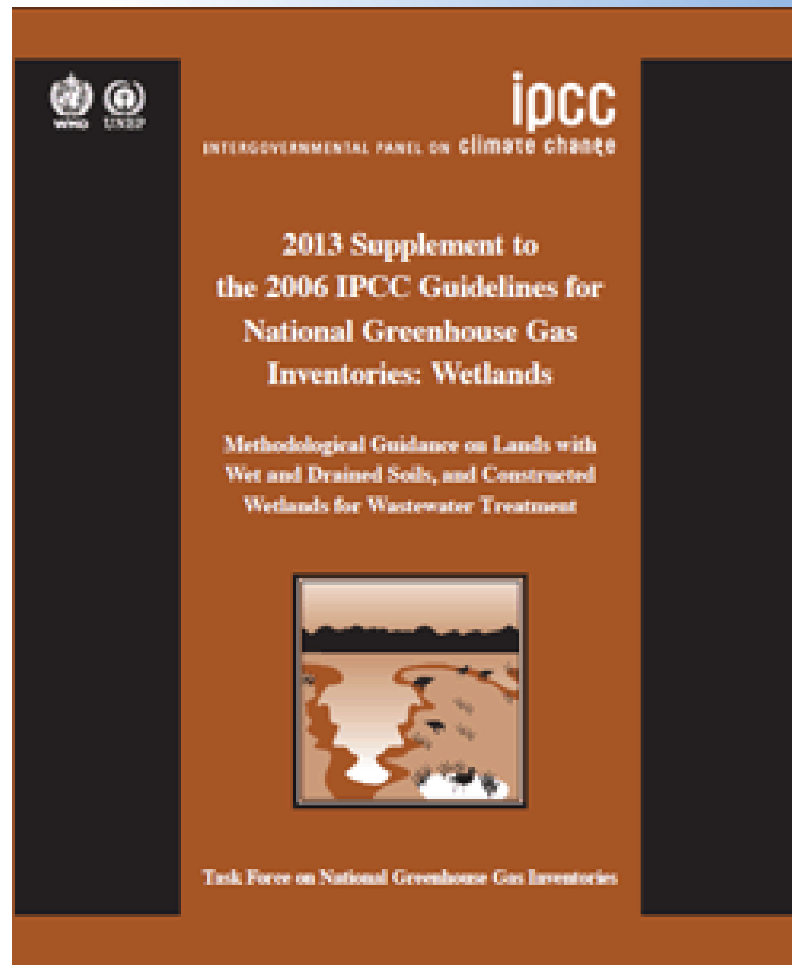
of America's

Natural Resources

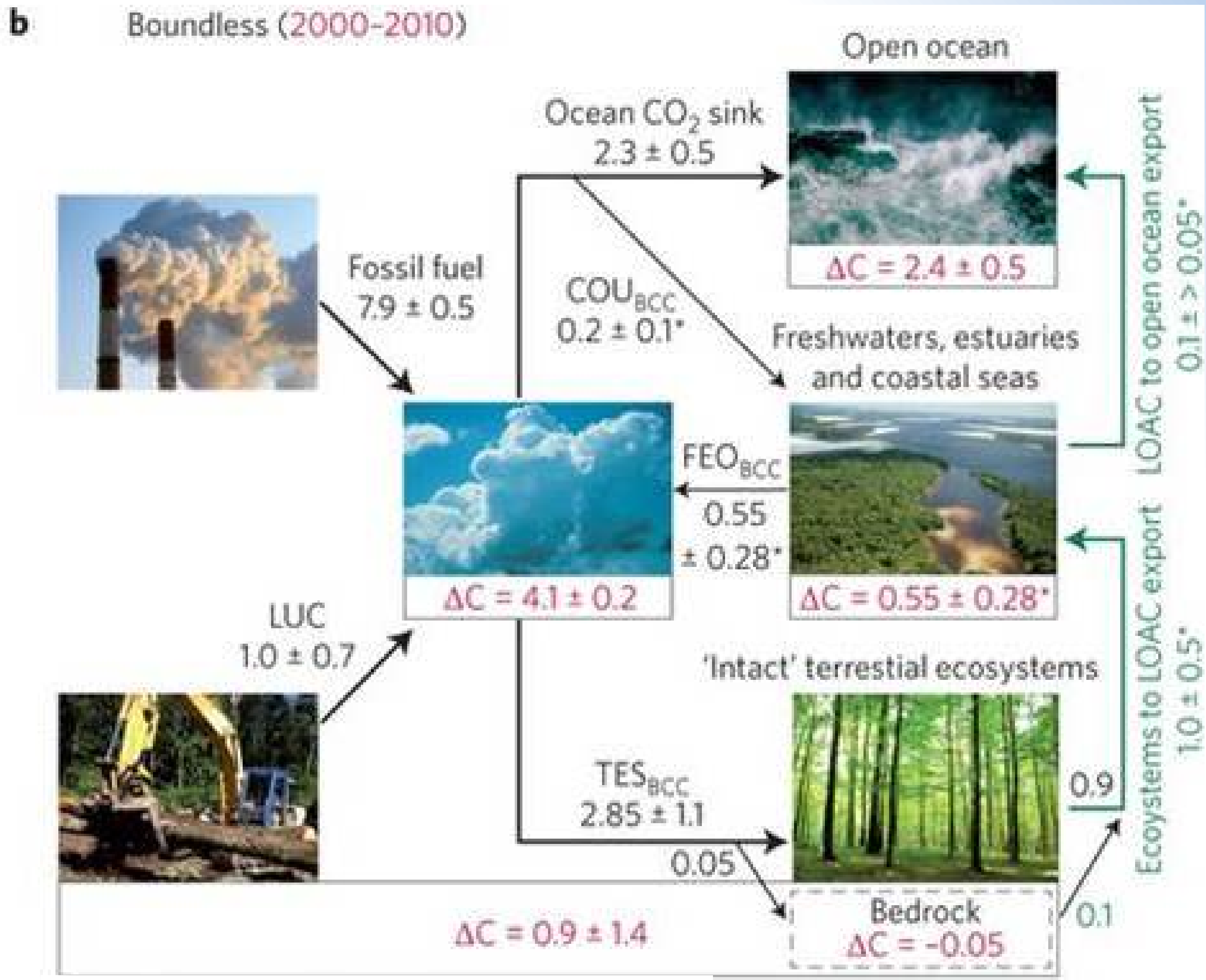
COUNCIL ON CLIMATE PREPAREDNESS AND RESILIENCE

VCS | VERIFIED CARBON STANDARD

A Global Benchmark for Carbon



Critical Need to fill the Coastal C Knowledge Gap



Regnier et al 2013 Nature Geosciences

Proposed network and database: Principles

- Provide scientific leadership
- Global coverage
- Inclusive and open
- Bi-directional communication between data providers and users
- Flexible
- Future thinking
- Scientifically rigorous and credible

Critical elements of the SBC network

- Community-driven
- Policy relevant but science focused
- Credible, reliable & traceable dataset
- Sustainable (funding, staff, ongoing participation and community engagement)
- Facilitate collaboration with other networks
- Training & outreach

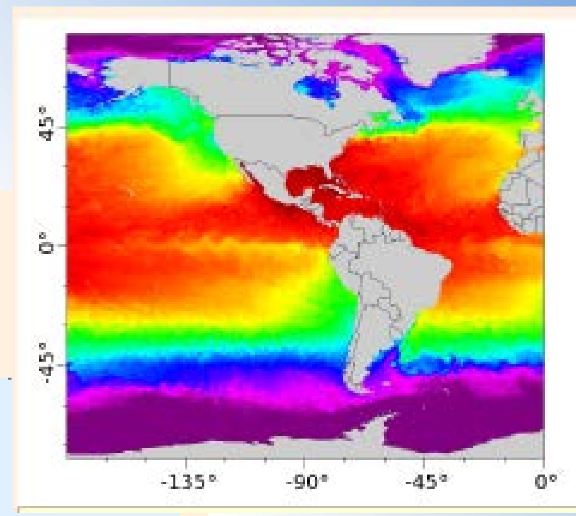
Seagrasses

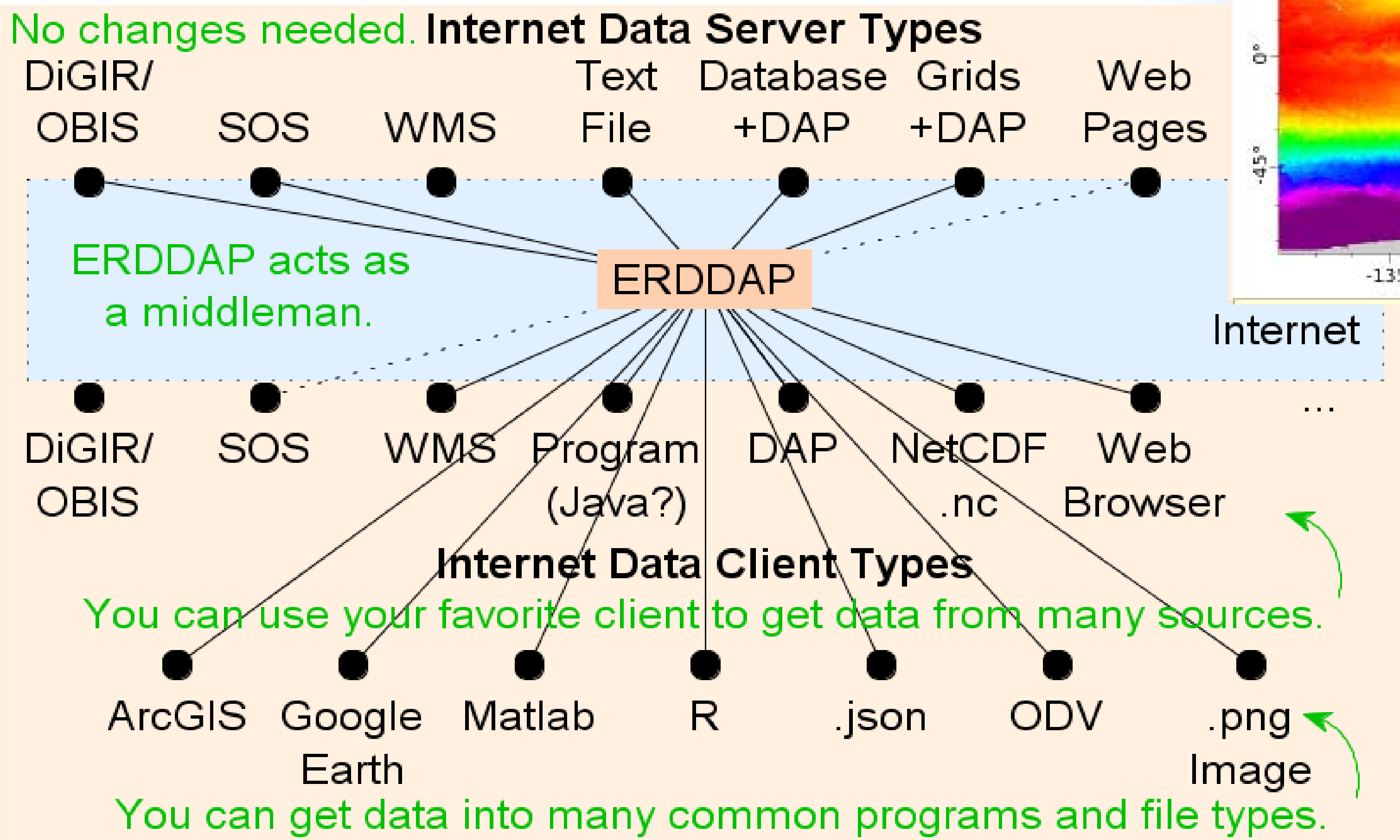
		Parameter	Level of information needed for a particular parameter		
			Minimum	Optimal	Ideal
Basic ecosystem descriptors					
Carbon stock descriptors - there will be multiple data points per sample site location because of measurements being taken from multiple slices from within any given core sample					
	Above Ground Stock				
Extent to which this parameter is important t measure	Minimum	**Mass**	total Dry Weight (DW)	DW per components (leaves, flowers, fruits)	previous, dated, estimates of mass
	Minimum	**Organic matter /Carbon**	Loss on ignition (wt%)	Direct determination of organic carbon content specify whether or not epiphytes were removed	Direct determination of organic carbon content by component
	Optimum	**Nitrogen (N)**	N content, unit	N and/or P content per component	previous, dated estimates
	Optimum	**Phosphorous (P)**	P content, unit	N and/or P content per component	previous, dated estimates
	Optimum	**Inorganic matter/carbon**	indirect determination of IMC (eg. 1-Loss on ignition (wt%)	determination of inorganic carbon content	
	Optimum	**Epiphyte load**	mass of epiphyte per mass of seagrass leaf	LOI of epiphyte material	Measurement of Corg of epiphyte material
	Below Ground Stock				
	Sedimentary pool				
ent to which this parameter is important t measure	Minimum	**Core location**	lat/long		
	Minimum	**Core depth**	depth (cm)	basic core description	
	Minimum	**Core diameter**	diameter (cm)		
	Minimum	**Slice depth**	top, mid and bottom-depth of sample slice (cm)		
	Minimum	**Slice thickness**	Thickness (cm)		
	Minimum	**Vegetation**	Presence/absence (y/n)		
	Minimum	**Org Carbon (C)**	OM content and specify unit by LOI	Direct determination of organic carbon content	
	Minimum	**Bulk density**	dry bulk density (g/cm3), volume & mass dry	porocity, volume & mass wet	
	Optimum	**Nitrogen (N)**	determined as a fraction of DW		
	Optimum	**Phosphorus (P)**	determined as a fraction of DW		
	Optimum	**Inorganic Carbon**	indirect determination of IMC (eg. 1-Loss on ignition (wt%)	determination of inorganic carbon content	

ERDDAP as a user-friendly and cost-effective solution to build a network of data stores, link to existing datasets, and serve data through customizable queries

- **Leverages substantial, long-term investment in tool development**

Bob Simons, NOAA





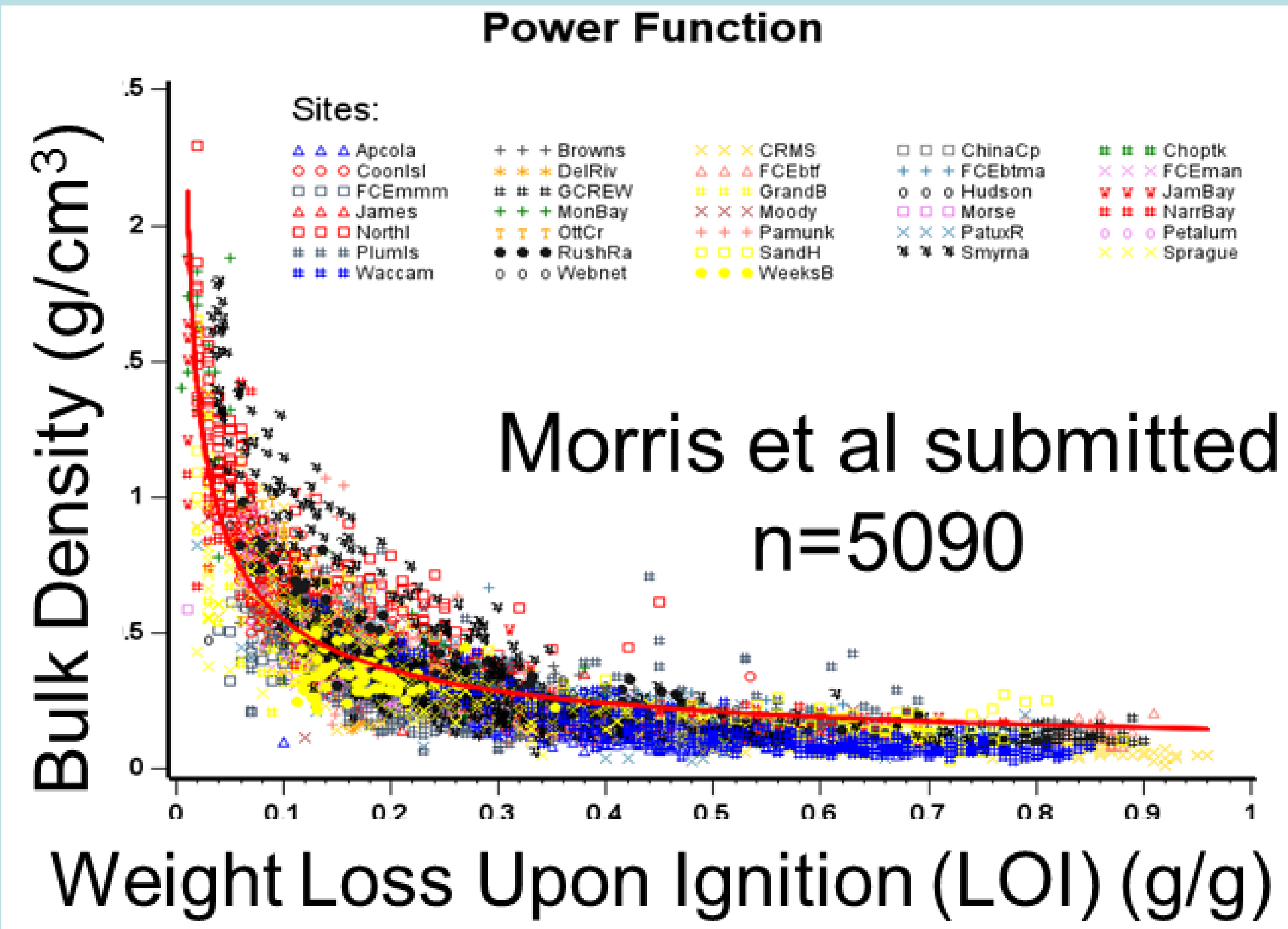
Data use policy

- Creative Commons
- Follow government requirements
- Multiple tiers of data (freely download vs. restricted data)
- DOI for data products

Resources required

- Full-time personnel to develop and maintain the database, network and website.
- Support for network activities (workshops, meetings)
- Funds for synthesis activities (postdocs)
- Data storage

The power of data sharing and synthesis (an example)



Improved Research Outcomes
What can we do together?

- Promote consistent and improved data analysis and collection techniques
- Detect change in blue carbon stocks and fluxes
- Improve holistic understanding of
  - coastal carbon cycle processes
  - contribution to large scale budgets
  - spatial and temporal variability
- Validate models
  - Empirical, process, neural network, etc.
  - Forecasting
  - Variability

The Network will enable critical synthesis activities

- Emissions accounting for wetlands in National GHG Inventories
- Substantial data increase for SOCCR
- Updates to IPCC emission factors
- Global & regional C budgets and models
- National, state and local level guidance on restoration and conservation activities (e.g. Massachusetts Wetland C Calculator; Nature Conservancy Emissions Calculator for Indonesian mangrove loss)
- Widespread, ongoing validation data for remote sensing and models
- Simple and visible way to make government data publically available
- Value added to existing and future data collections as well as existing databases (ISCN, Ameriflux, CSIRO, USAID Central American data hub, SSURGO, LandCarbon, CDIAC, etc.)

Establishing a Global Science and Data Network for Coastal Blue Carbon (SBC)

Thank you!