Testing Ecosystem Accounting in the United States: A case study for the Southeast

NATIONAL ECOSYSTEM SERVICES PARTNERSHIP WEBINAR, 5/21/20

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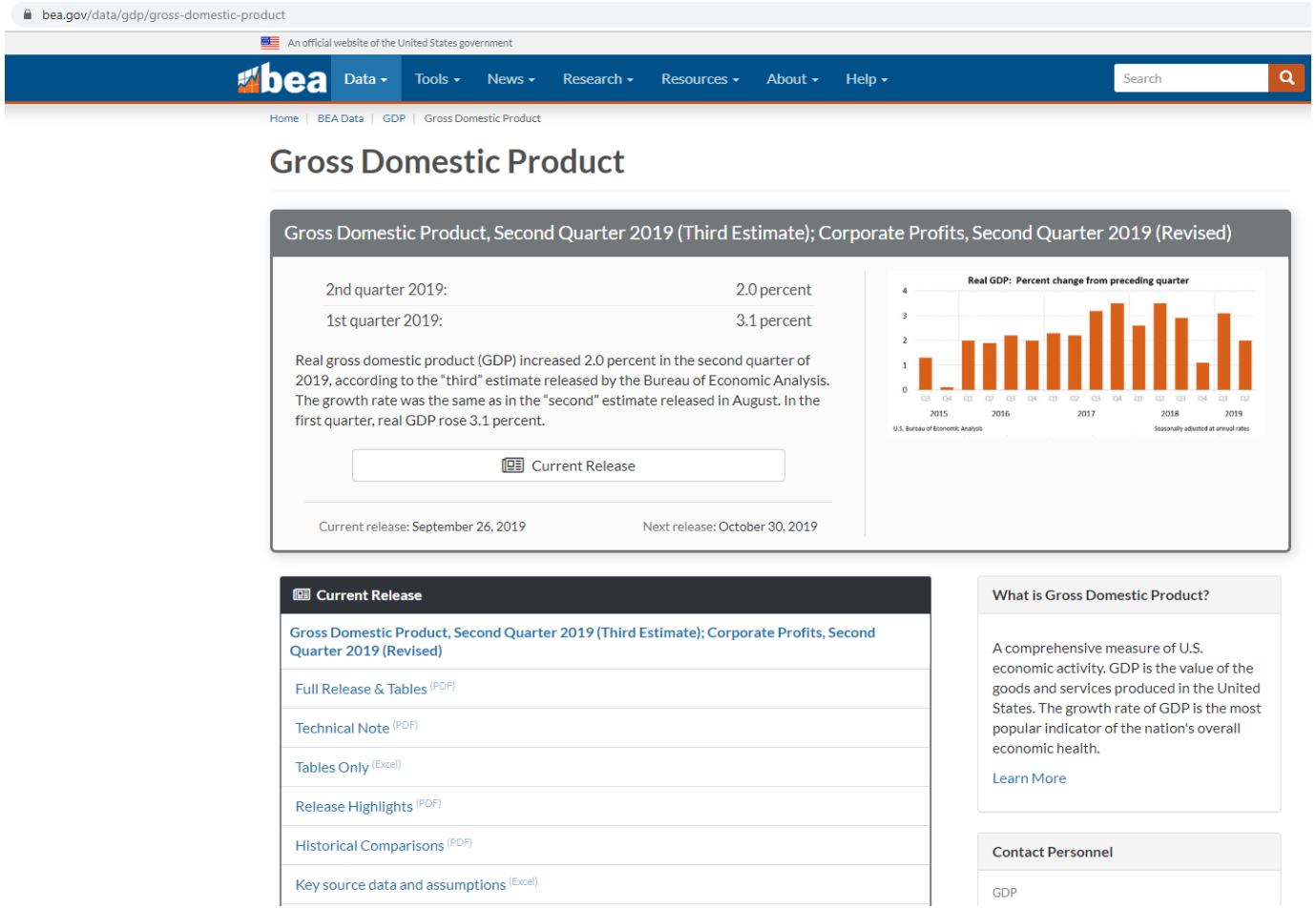
Economic accounts & natural resources

An “institutional miracle”?

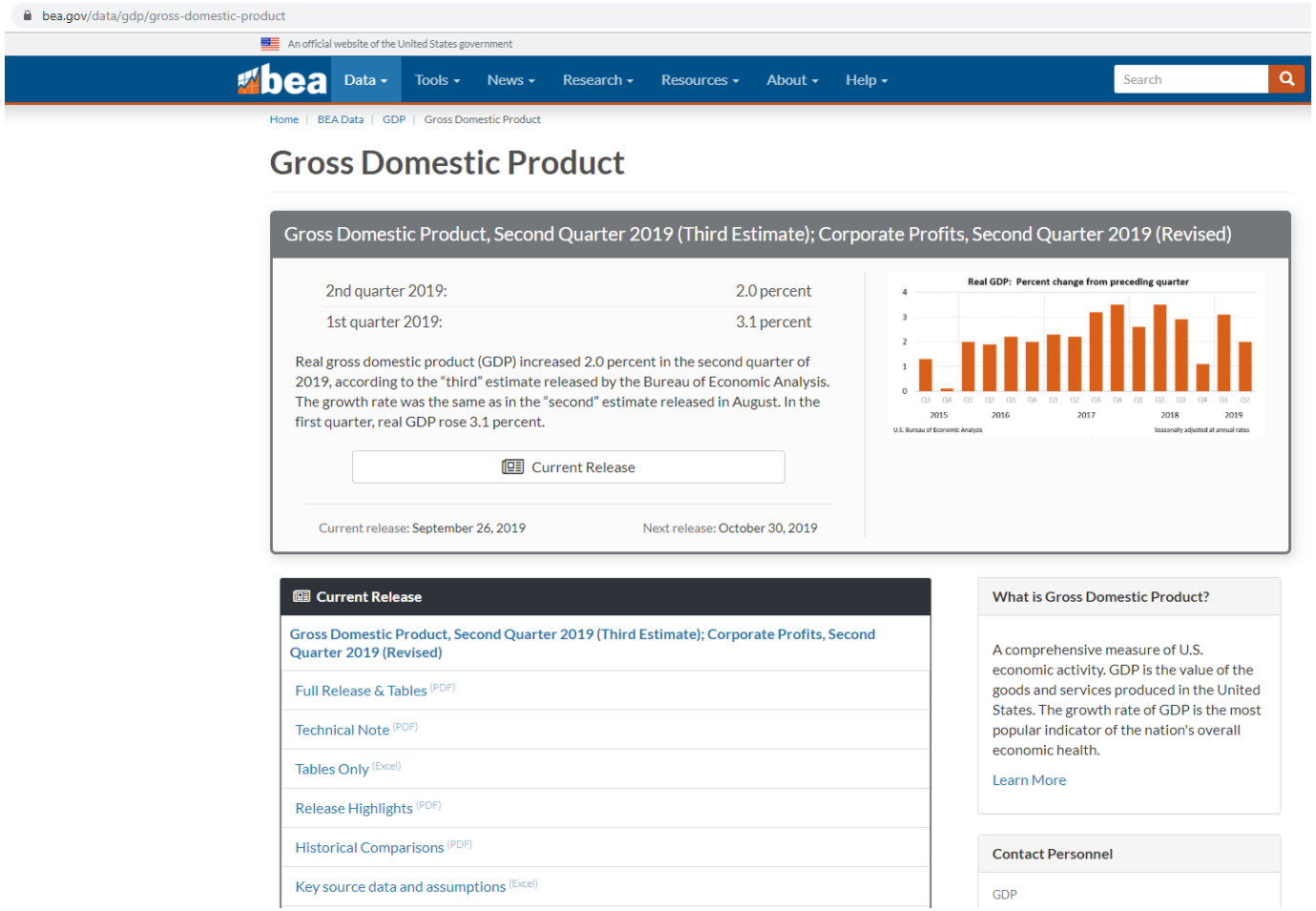
- Regularly produced & updated
  - Over time
  - Across industries
  - Multiple geographies (national-state-MSA-county)
- Independent & trusted
- Extremely high policy relevance
  - Support economic prediction (what will the effects of new policy x be on GDP, employment, trade…)



Economic accounts & natural resources

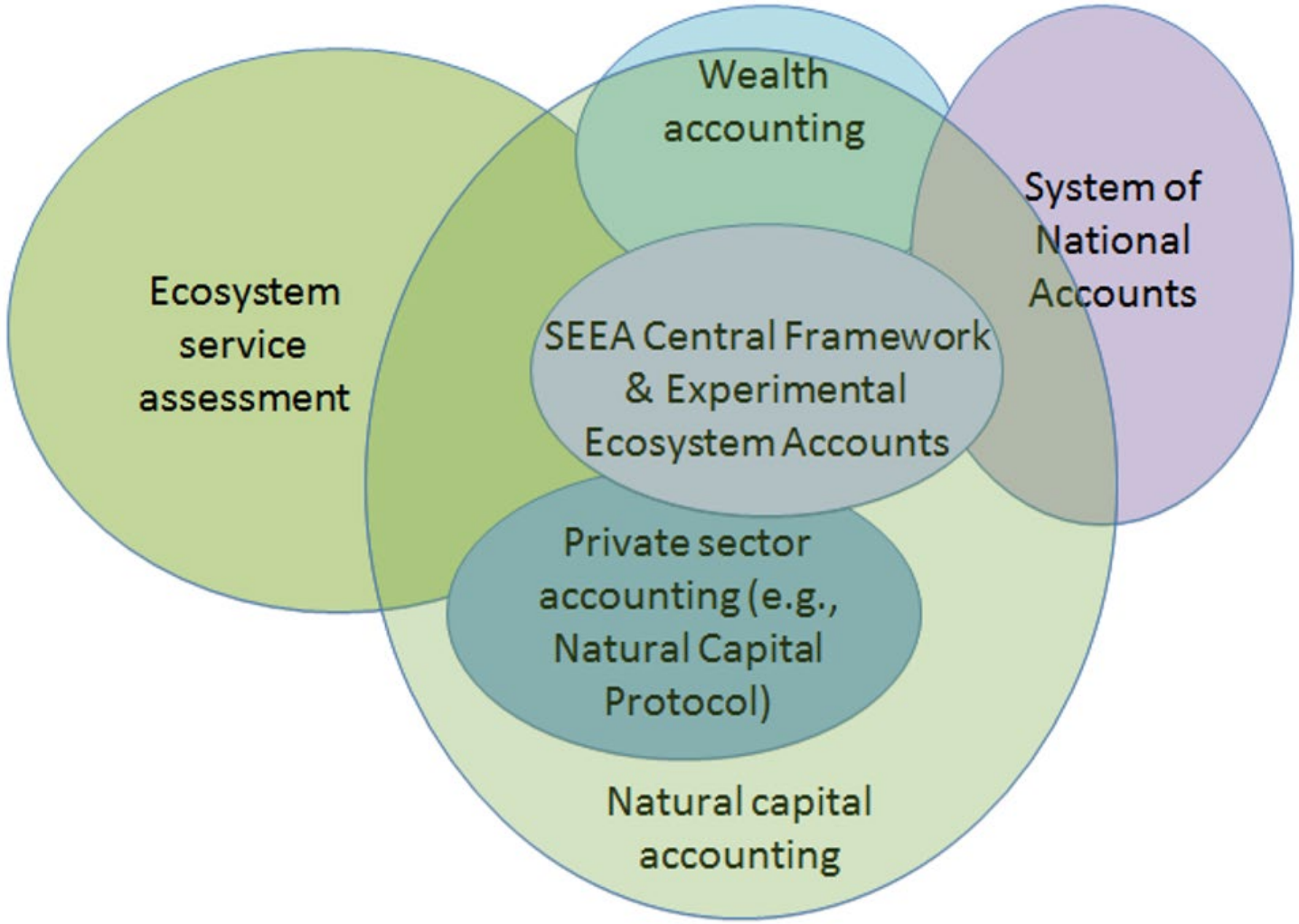
BUT well-known & significant flaws!

- Include the role of labor & capital in generating prosperity, but not natural resources
- Doesn't account for *depletion/damage* (or protection/restoration) of environment that impact future prosperity
- Excludes some ecosystem services entirely (e.g., regulating ES)



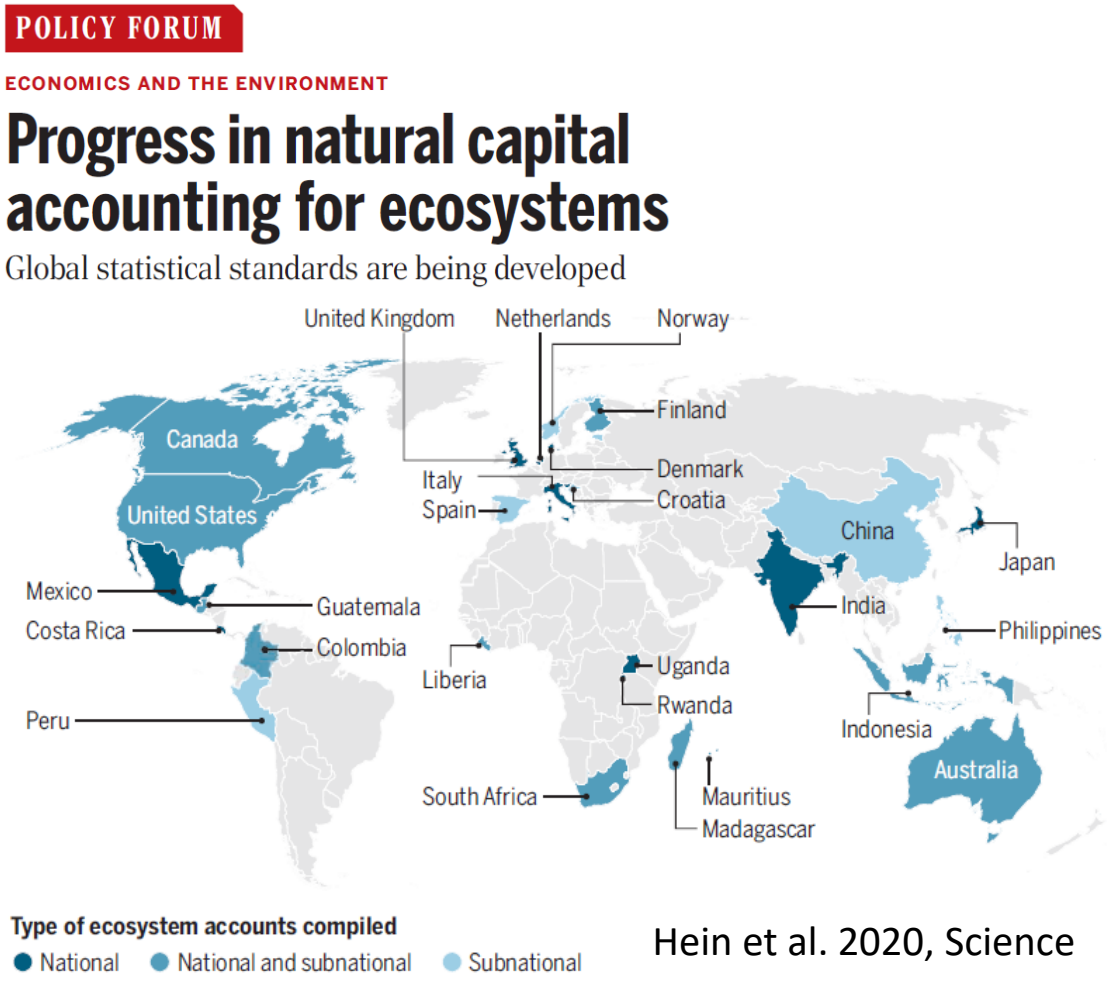
Natural capital accounts, economic accounts, & ecosystem services

- System of National Accounts misses key pieces of economic value/production (natural capital)
- Ecosystem services assessments don't tie well to economic data



System of Environmental-Economic Accounts: International standards & applications

https://seea.un.org/content/homepage



Hein et al. 2020, Science

Developing pilot accounts for the U.S.: 2016-present

- Next steps: How can this information be used in decision making? (it won't go anywhere if it's not useful)
- Outreach to agencies & others, on "use cases"

- **Participants**

USGS science for a changing world

BEA BUREAU OF ECONOMIC ANALYSIS U.S. DEPARTMENT OF COMMERCE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

NOAA

FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE

DEPARTMENT OF STATE UNITED STATES OF AMERICA

- **Funders**

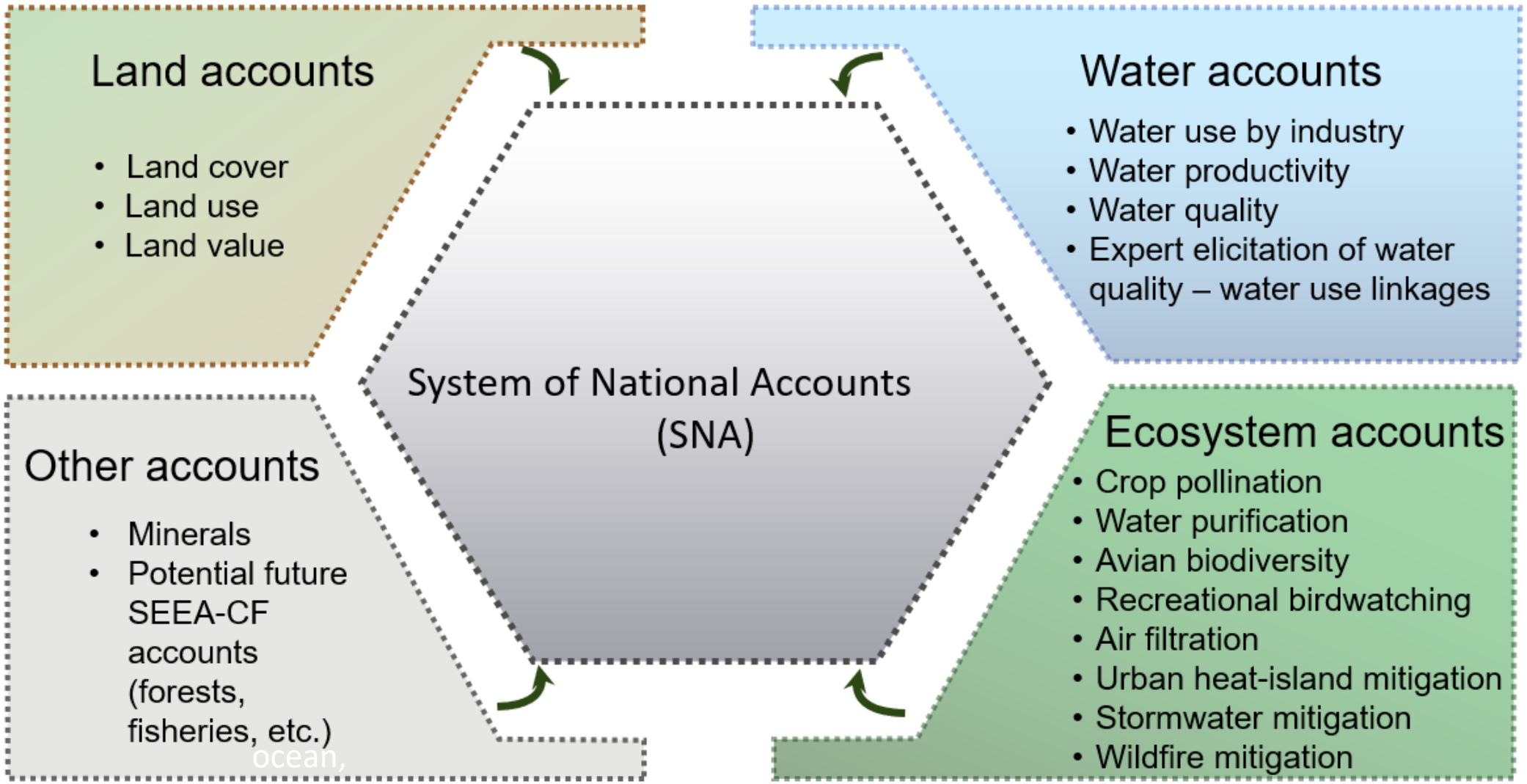
Powell Center

SESYNC NATIONAL SOCIO-ENVIRONMENTAL SYNTHESIS CENTER

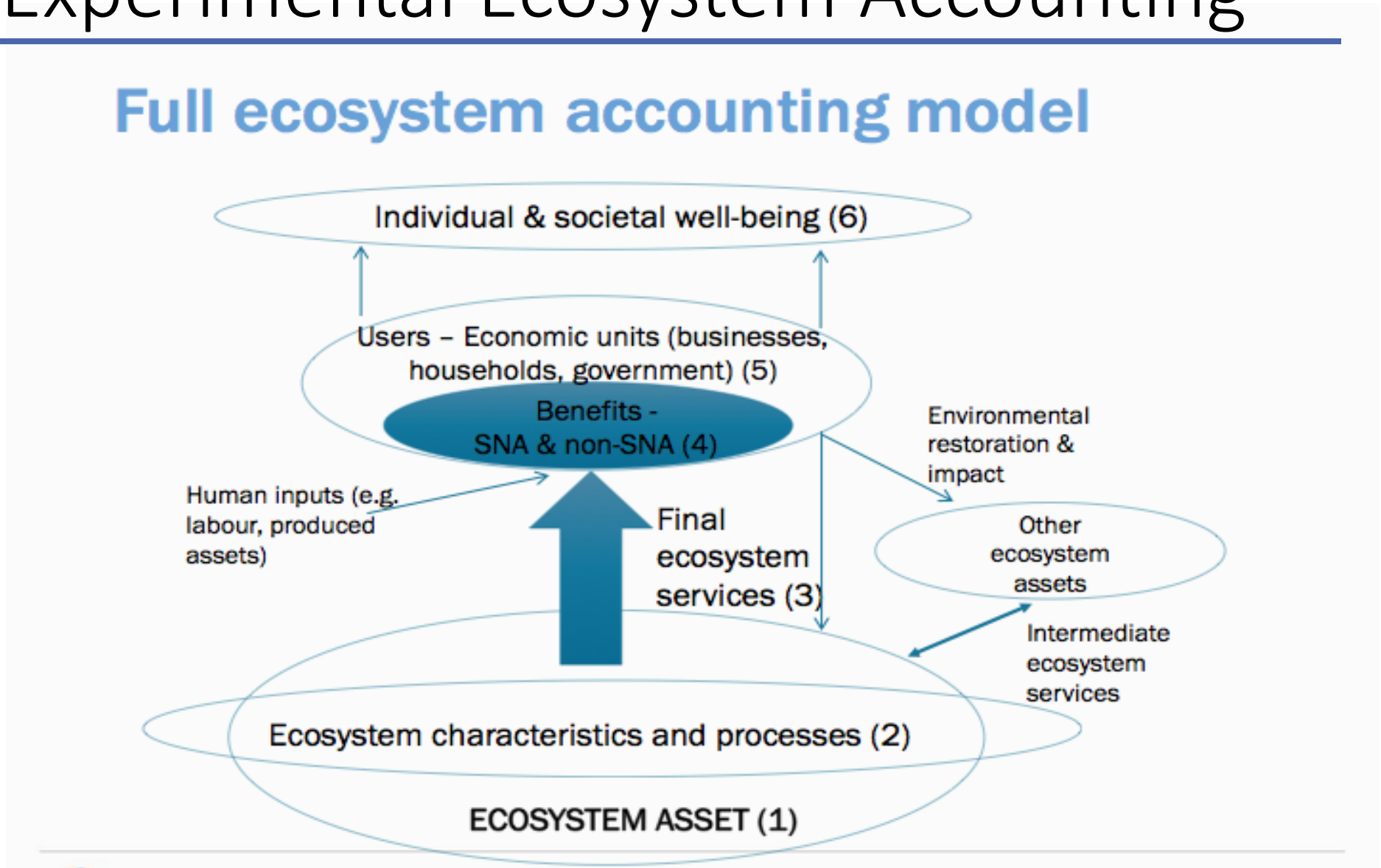
SOUTHEAST Climate Adaptation Science Center

NASA

Piloting natural capital accounts for the U.S.

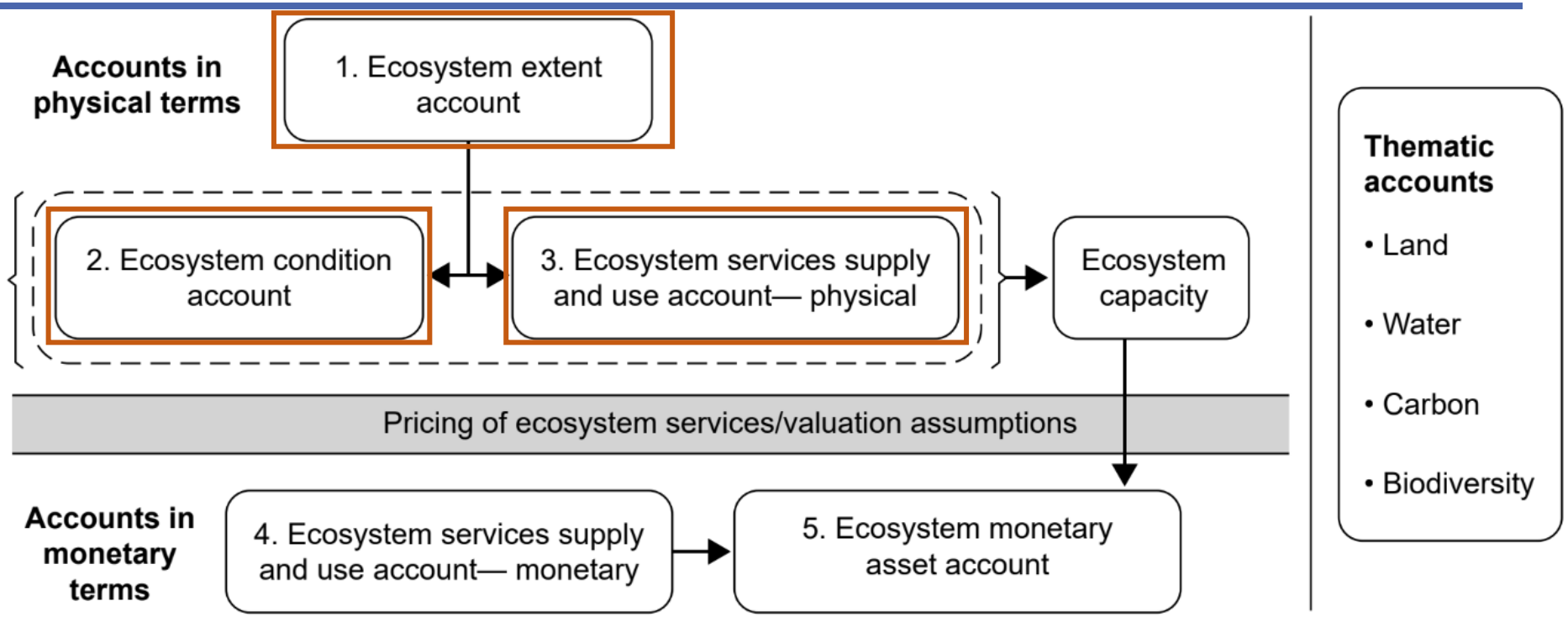


SEEA Experimental Ecosystem Accounting



(Figure 1, December 2015 draft of U.N. et al., 2017 "SEEA EEA Technical Recommendations")

SEEA Experimental Ecosystem Accounting



- *Ecosystem extent* begins with spatial areas, "ecosystem assets"
- *Ecosystem assets* hold biotic and abiotic components that in their *condition* produce things that when used/appreciated/transacted by *economic units* record as *ecosystem services*
- Physical flows and monetary flows are separate accounts
- Thematic accounts cover critical factors that span ecosystem assets
- Integration: SEEA-EEA entries should minimize overlap with SNA entries

SEEA-EEA Account 3: Ecosystem services supply and use account – physical

ECOSYSTEM SERVICES SUPPLY TABLE

		Type of economic unit	Type of Ecosystem Unit
Ecosystem services Provisioning services Regulating services Cultural services		A	B
Products		C	D

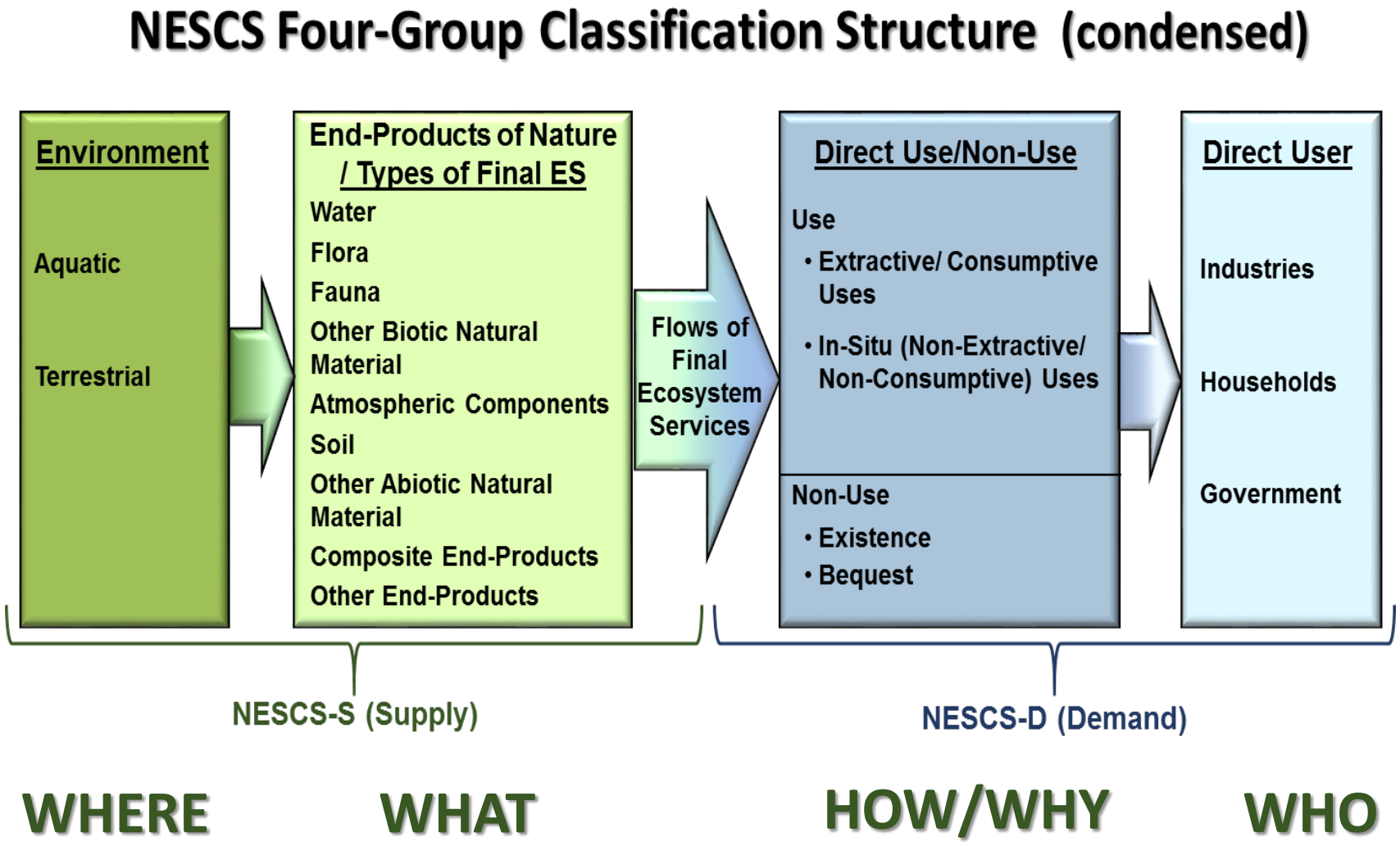
ECOSYSTEM SERVICES USE TABLE

		Type of economic unit	Type of Ecosystem Unit
Ecosystem services Provisioning services Regulating services Cultural services		E	F
Products		G	H

SEEA EEA ecosystem services supply and use table structure (reduced from December 2015 draft of U.N. et al., 2017)

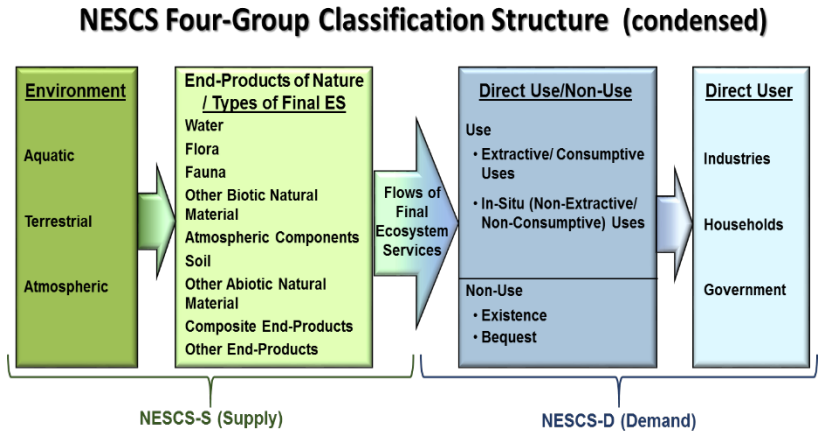
- Only Ecosystem Units(/assets) can supply ES, never Economic Units
- Only "final" ES; must be *used/appreciated/transacted* in area and year
- Quadrants B & E are equal in total, and by row

Defining ecosystem services with NESCS



Defining ecosystem services with NESCS

US NCA for Ecosystem Accounting chooses SEEA EEA framework, and tests NESCS framework for ES supply and use tables



ECOSYSTEM SERVICES SUPPLY TABLE

Direct user

Environment

		Type of economic unit	Type of Ecosystem Unit
Ecosystem services			
Ecological end-products		A	B
Products		C	D

ECOSYSTEM SERVICES USE TABLE

		Type of economic unit	Type of Ecosystem Unit
Ecosystem services			
Ecological end-products		E	F
Products		G	H

Pilot ecosystem account objectives and data considerations

Pilot account objectives

- Test ecosystem accounting framework with US data
- Develop pilot ecosystem accounts for the southeastern US
- Explore how account information can be used to inform decision-making

Data considerations for pilot accounts


Data should be publicly available on a national scale


Accounts summarized geographically and by ecosystem type


Analyses should be updateable – tracking over time is essential


Avoid proprietary tools and models

Pilot ecosystem account content

Using NESCS framework, we determined which of our data met the criteria for inclusion in a supply-use account (represent direct use by people), and which better fit in the more flexible condition account.

Supply-use account	Condition account
• Recreational birding (birding days) • Air quality (concentration of pollutants relevant to human health in developed areas)	Metrics related to… • Bird biodiversity • Air pollutant removal • Wild pollination • Water purification • Carbon storage

for more detail, see Warnell et al. 2020

Using pilot accounts – understanding provision by ecosystem type

Recreational birding, 2011

Ecosystem type (land cover)	Thousands of birding days
Offshore	1,236
Open Water	5,207
Developed - Open	10,022
Developed - Low	7,420
Developed - Medium	3,553
Developed - High	1,046
Barren	1,408
Deciduous Forest	7,173
Evergreen Forest	3,816
Mixed Forest	692
Shrub/Scrub	1,966
Grassland/Herbaceous	1,833
Pasture/Hay	4,050
Cultivated Crops	2,634
Woody Wetlands	4,964
Emergent Herbaceous Wetlands	3,695
Total	60,715

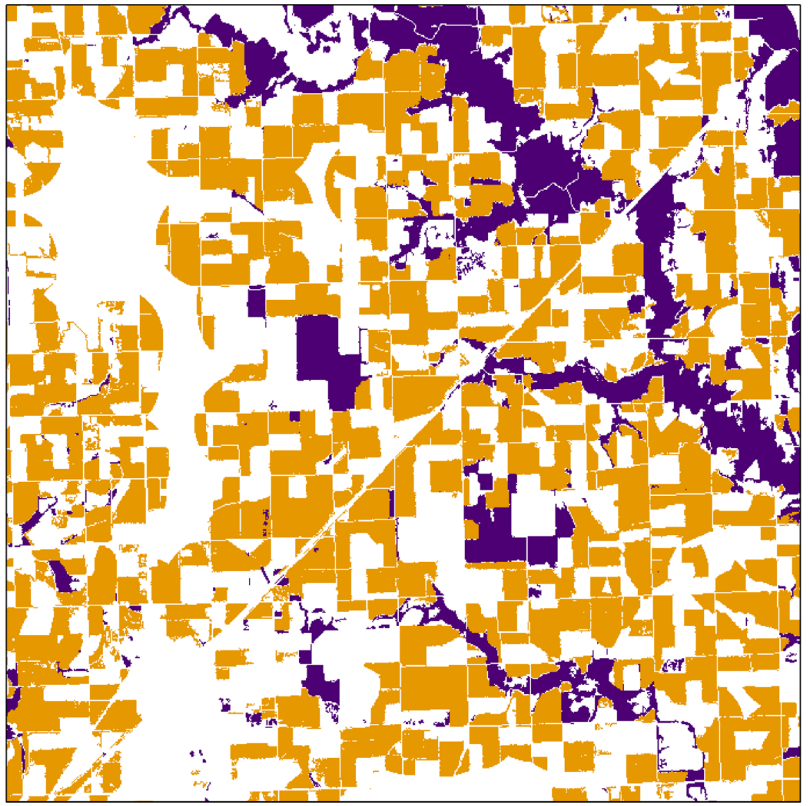
Developed land supplied more than 1/3 of birding days in the southeast

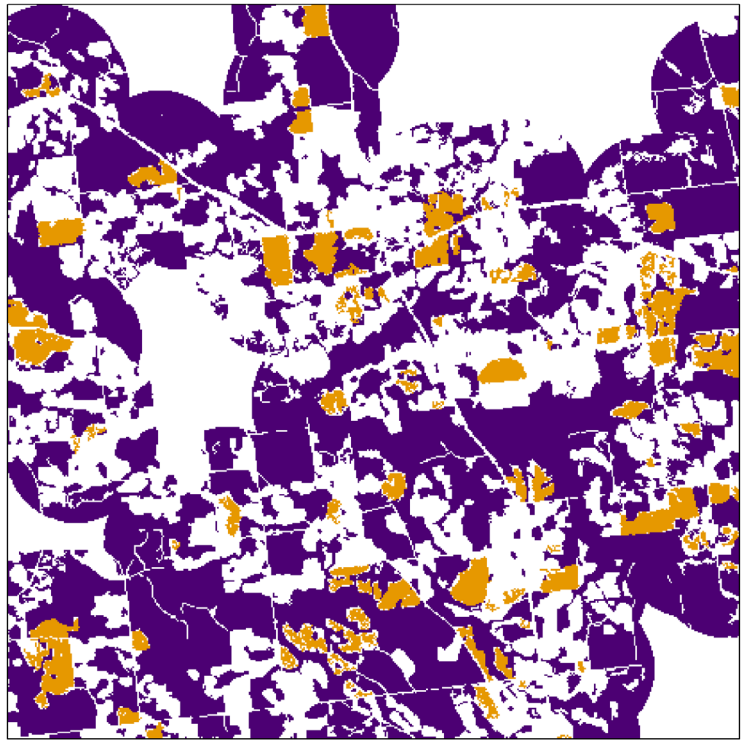
Forests, open water, and wetlands also important ecosystem types for birding in the southeast

Using pilot accounts – cross-state comparison

Ratio of pollinator habitat to pollinator-dependent crops

State	Ratio
AL	7.96
AR	0.57
FL	3.22
GA	9.85
LA	1.51
MO	1.25
MS	2.00
NC	5.84
SC	7.95
TN	3.01





Using pilot accounts – change over time (2010-2015)

Final ecosystem service	Ecological end-product (NESCS element b)	User(s) (NESCS element d)	Benefit to user	Related metrics in pilot accounts (account type)
Reduction of air pollutants	Ecological structures (i.e., vegetation) responsible for removing air pollutants	Households	Reduced risk of adverse health outcomes	Removal of target air pollutants (supply and use account) Concentrations of target air pollutants, weather conditions, and percent canopy cover (condition account)

Changing Conditions – Drivers of Ecosystem Service Rates in the S.E.

Air pollutants	Percent change
CO	-7.80%
NO_2	-3.96%
O_3	-8.89%
PM_{10}	0.40%
$PM_{2.5}$	-4.93%
SO_2	-48.07%

Weather Conditions	Percent Change
Wind Speed	5.59%
Temperature	1.88%
Precipitation	39.71%

= Increase

= Decrease

Percent Canopy Cover = Constant at 2010 numbers (58%)

Changes in Ecosystem Service Supply (2010-2015)

South East US Region

Pollution Removal	Percent Change
CO	-6.19%
NO_2	-12.80%
O_3	-6.02%
PM_{10}	-9.18%
$PM_{2.5}$	17.10%
SO_2	-46.39%

= Increase

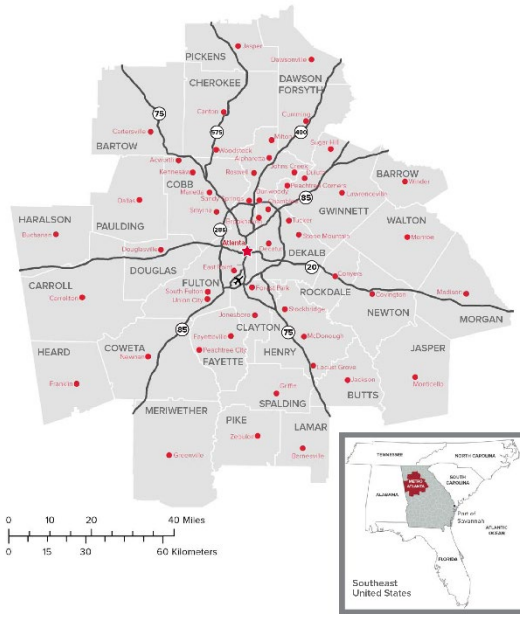
= Decrease

State Differences

		Alabama	Arkansas	Florida	Georgia
Mean Concentration Difference (ppb except for PM (µg/m3))	CO	39.01	−85.14	−66.14	5.80
	NO_2	3.19	−1.65	−0.25	−0.63
	O_3	−2.70	−3.13	−2.33	−0.86
	PM_{10}	−4.52	0.90	−3.17	−0.52
	$PM_{2.5}$	2.42	−3.14	0.81	−1.71
	SO_2	−0.56	−0.72	−0.25	−0.53
Removal Rate Difference (tonnes/yr)	CO	2,183	−3,402	−2,752	450
	NO_2	31,893	−7,017	4,123	1,624
	O_3	−33,689	−35,481	−33,375	−23,662
	PM_{10}	−90,228	11,956	−55,737	−12,394
	$PM_{2.5}$	11,017	−3,514	8,356	1,299
	SO_2	−8,997	−6,613	−1,063	−12,234
Weather Difference	Wind Sp. (m/s)	0.05	0.07	0.08	0.06
	Temp. (°C)	1.22	−0.29	1.79	0.96
	Precip. (mm/yr)	697.92	573.10	193.34	373.46

Using pilot accounts – integration with other accounts

Atlanta-Sandy Springs-Roswell MSA



Account	Metric		% change, 2001-2011
Land accounts	Developed land cover		17.2%
	Agricultural land cover		-6.3%
	Forested land cover		-9.3%
	Other land cover		18.6%
Water accounts	Total water use (million gallons/day, 2000-2010)		-57.8%
	Water productivity ($/100 gallons water use, 2000-2010)		153.3%
	% of water-quality monitoring sites reporting significant declines, 2002-2012)	Nitrate (n=7)	57%
		Specific conductance (n=6)	67%
		Total suspended solids (n=4)	25%
Ecosystem accounts	% of flowpath in purifying land cover		-18.2%
	Mean annual concentration, CO (2010-2015)		21.3%
	Mean annual concentration, PM_{10} (2010-2015)		-18.2%
	Mean annual concentration, $PM_{2.5}$ (2010-2015)		-10.2%
	Mean annual concentration, SO_2 (2010-2015)		-57.0%
	Mean annual removal rates, CO (2010-2015)		25.3%
	Mean annual removal rates, PM_{10} (2010-2015)		-20.5%
	Mean annual removal rates, $PM_{2.5}$ (2010-2015)		11.0%
	Mean annual removal rates, SO_2 (2010-2015)		-49.2%
	Total precipitation		31.9%
	Temperature		6.9%
	Recreational birding-days		209.6%
	Carbon storage (2001-2010)		-1.6%
Urban ecosystem accounts	Energy savings due to cooling effect of urban trees		2%
	Rainfall intercepted by urban trees		-8%
Economic accounts	GDP, all industries		8.8%
Population (2000-2010)			24.0%

Data gaps and research needs - general

- Lack of direct measurements of ecosystem services to provide information for supply-use tables (for some ecosystem services, such measurements are not yet possible)
- Limited spatial and temporal resolution of available data
- Challenges using and validating predictive models in large, heterogeneous environments; when adequate models do exist, they are often extremely data intensive and include proprietary components

Data gaps and research needs – air purification

Ecosystem service	Ideal measure for supply and use table	Key questions related to data gaps
Delivery of volume of air cleaned to certain quality	Reduced exposure to air pollutants (physical supply and use table) Number of hospitalizations and healthcare costs avoided due to air pollutant removal (monetary supply and use table)	What effect would updated vegetation cover data including corrections for urban landscapes have on our trend analysis? This would provide tighter linkages between condition and supply and use. How to spatially separate exposure areas from areas of non-use? More frequent updates to demographic information on where people are located would be helpful.

Data gaps and research needs – wild pollination

Ecosystem service	Ideal measure for supply and use table	Key questions related to data gaps
Wild pollination	Wild pollination of pollinator-dependent plants, pollinator visits/flower (physical supply and use table) Additional revenue attributable to wild pollination (monetary supply and use table)	What are the most important wild pollinators? What is the relationship between key habitat characteristics and wild pollinator abundance? What is the relationship between wild pollinator activity on crop fields and crop yield response?

Data gaps and research needs – water purification

Ecosystem service	Ideal measure for supply and use table	Key questions related to data gaps
Delivery of volume of water cleaned to certain quality	Amount of water used by individuals or economic units, cubic meters (physical supply and use table) Avoided water treatment cost due to water purification by ecosystems (monetary supply and use table)	How much water pollution (e.g., sediment, nitrate) do various ecosystems remove, and how does this translate to reduced concentrations in source water bodies? What pollutant concentrations are required for various uses? What is the relationship between pollutant concentrations in source water and water treatment costs?

Data gaps and research needs – recreational birding

Ecosystem service	Ideal measure for supply and use table	Key questions related to data gaps
Presence of composite products including bird biodiversity, bird population, and other unknown components that attract birders	Number of birding days (physical supply and use table) Amount spent on equipment and travel for recreational birding (monetary supply and use table)	What factors drive use of recreational birding sites? (Some research related to particular bird species has been done in certain locations, e.g., Kolstoe and Cameron, 2017)

Next steps for EA in the US

Ecosystem account updates and expansion

- Update existing accounts to use newly available data
- Expand geographic scope of accounts to continental US
- Incorporate new ecosystem services to meet user interests

Support decision-makers in using ecosystem accounts

- Create accounts for specific geographic areas (e.g., states, land managed by a government agency)
- Track status and trends of critical natural assets through ecosystem, water, land, and carbon accounts
- Use these experiences to make future versions of accounts more relevant to decision-makers

Please contact us if you're interested in exploring how ecosystem accounts could be used in your work!

Thank you!

Pilot ecosystem accounts paper in *Ecosystem Services*: doi.org/10.1016/j.ecoser.2020.101099
Additional papers forthcoming in *Ecosystem Services* as part of special issue on natural capital accounting in the U.S. & Europe

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- Participants

- Funders