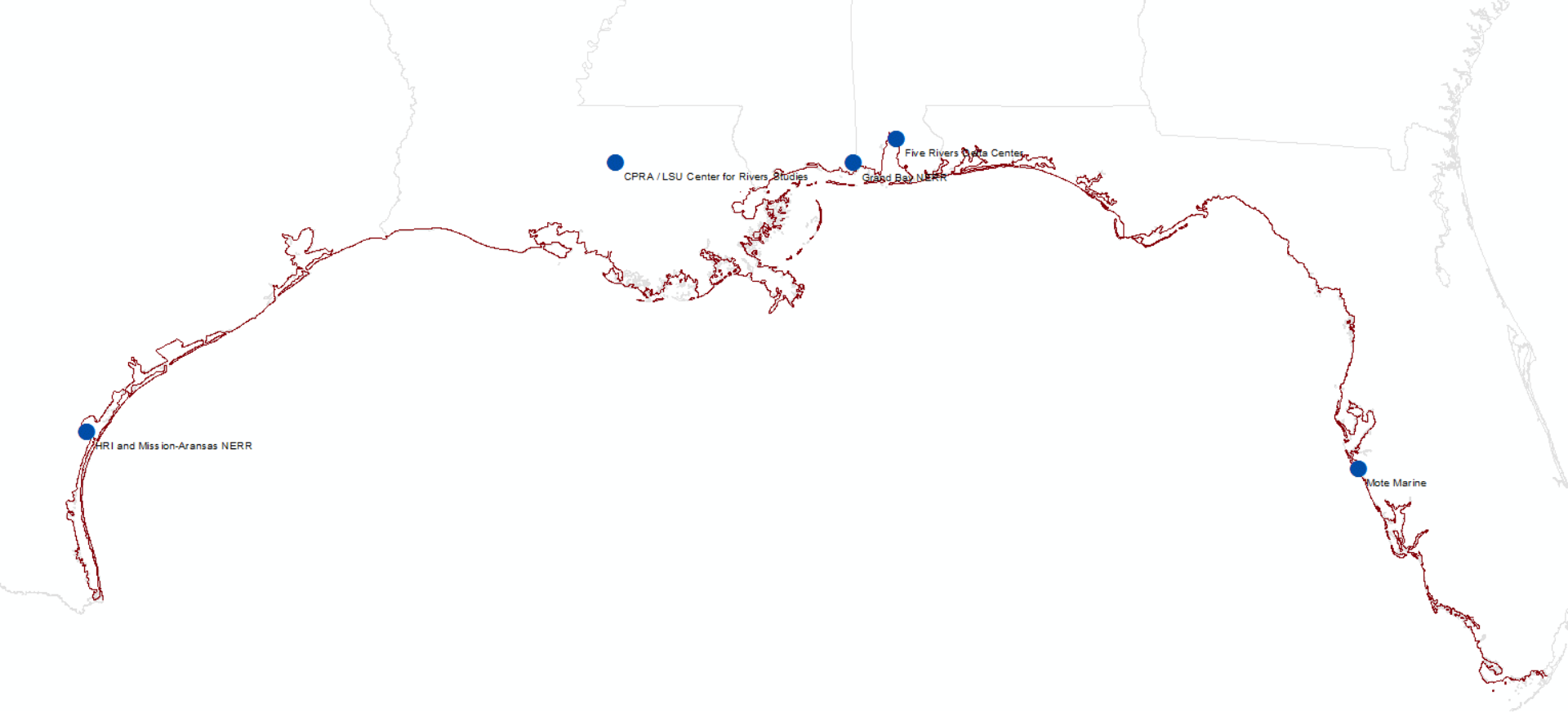


Using Remote Sensing to Quantify Ecosystem Services for Improved Coastal Decision Making

The Balmoral Group

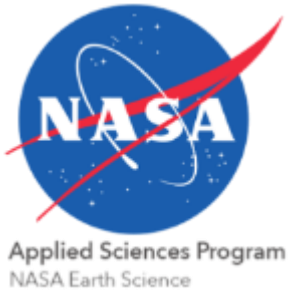
NASA Applied Sciences Program
NASA Earth Science

The Nature Conservancy

Using Remote Sensing to Quantify Ecosystem Services for Improved Coastal Decision Making

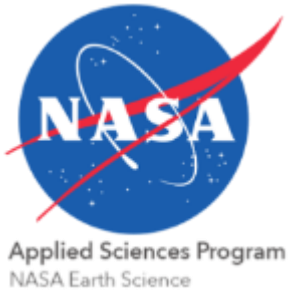
Who are we?

- **Maury Estes** – Research Scientist at UAH; NASA Earth Science Division project manager
- **Keith Gaddis** – Senior Support Scientist; NASA Earth Science Division project manager
- **Valerie Seidel** – Principal Economist, Project Director; The Balmoral Group
- **Dan Dourte** – Hydrologist; The Balmoral Group
- **Craig Diamond** – Environmental Scientist; The Balmoral Group
- **Christine Shepard** – Director of Science, Gulf of Mexico Program; The Nature Conservancy



Meeting Objectives

- Share the challenges and opportunities of coastal resource managers using remote sensing data to quantify coastal ecosystem services
- Identify next steps toward applications of remote sensing to ecosystem service information for better coastal management and planning

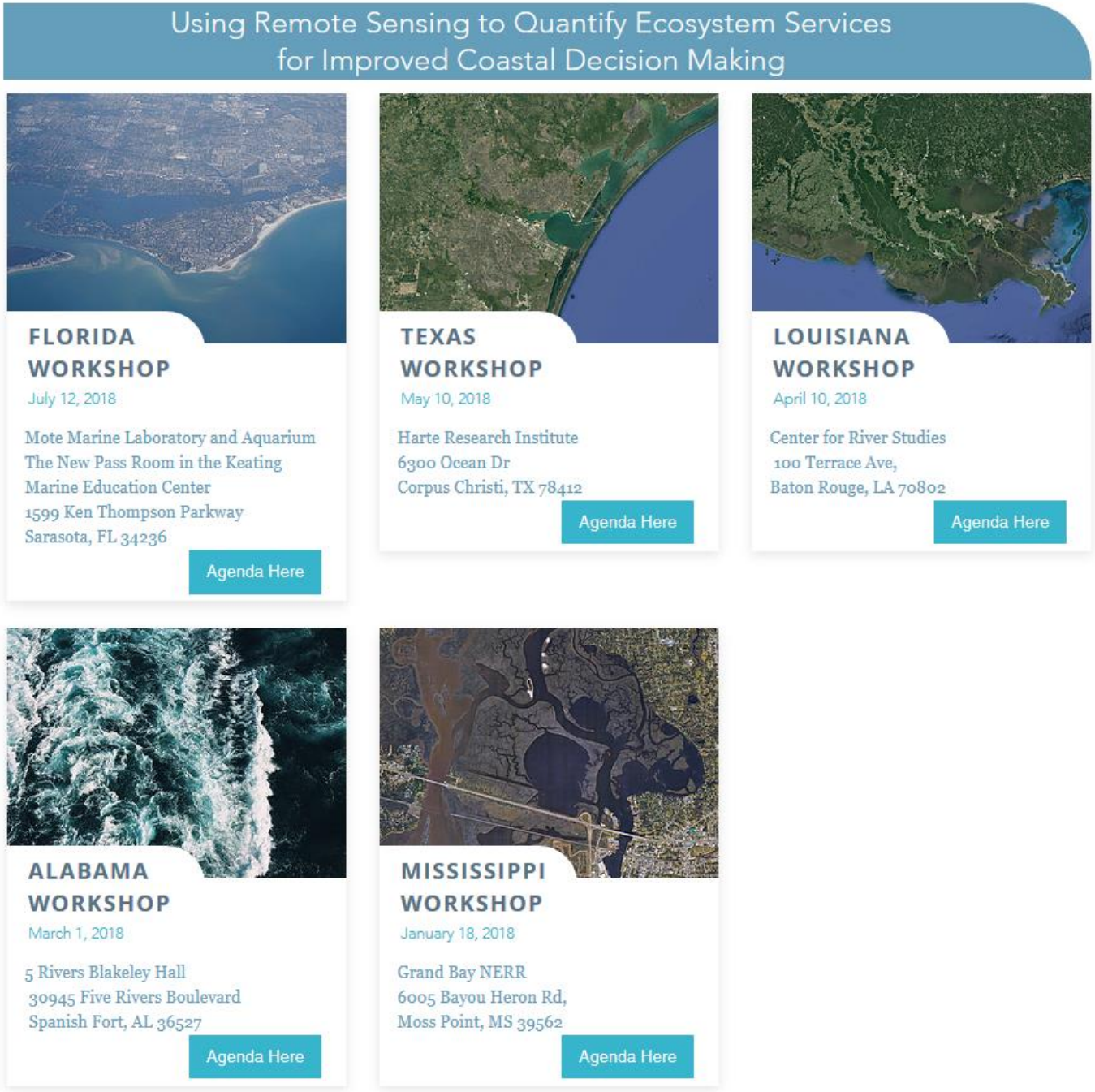


The Workshops: 5 Gulf Coast States

Jan to Jul 2018

3 pieces

- Remote Sensing: data literacy and access
- Ecosystem Services: model options and valuation
- Learning from participants



Workshop - recap

Remote sensing data

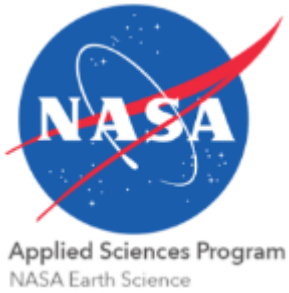
- what it is, how it can help, where it comes from, how to learn about it and use it
  - NASA's Giovanni https://giovanni.gsfc.nasa.gov/giovanni/

  For exploring, web-based analysis of data

  - NASA's EarthData

  https://search.earthdata.nasa.gov/search

  For finding/retrieving remote sensing data



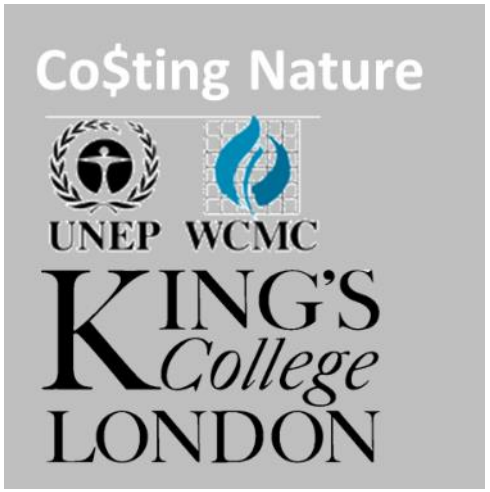
Workshop - recap

Options for estimating ecosystem services

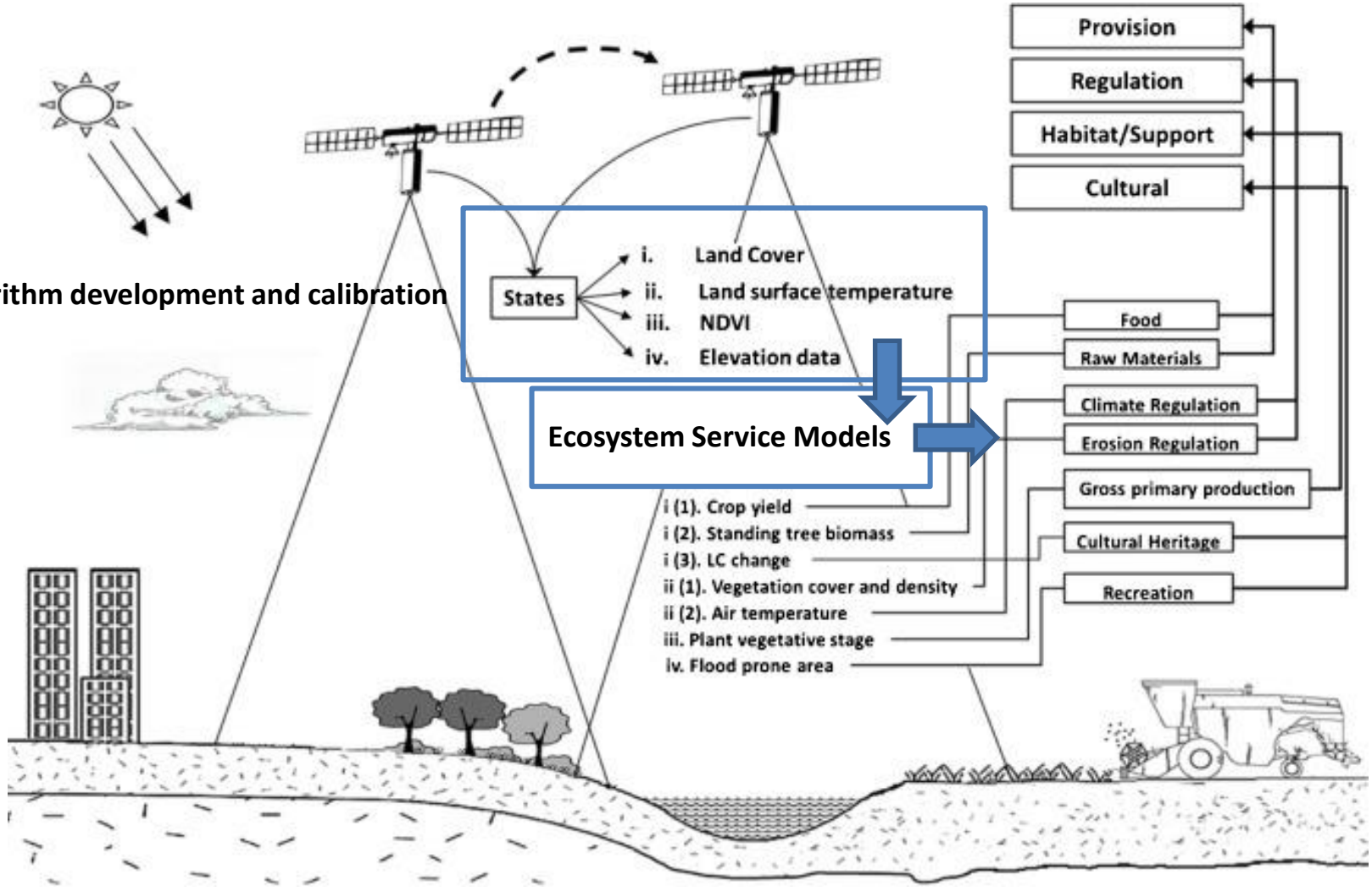
- How to put the pieces together
  - **InVEST**

    https://www.naturalcapitalproject.org/invest/
  - **Co$ting Nature**

    http://www.policysupport.org/costingnature

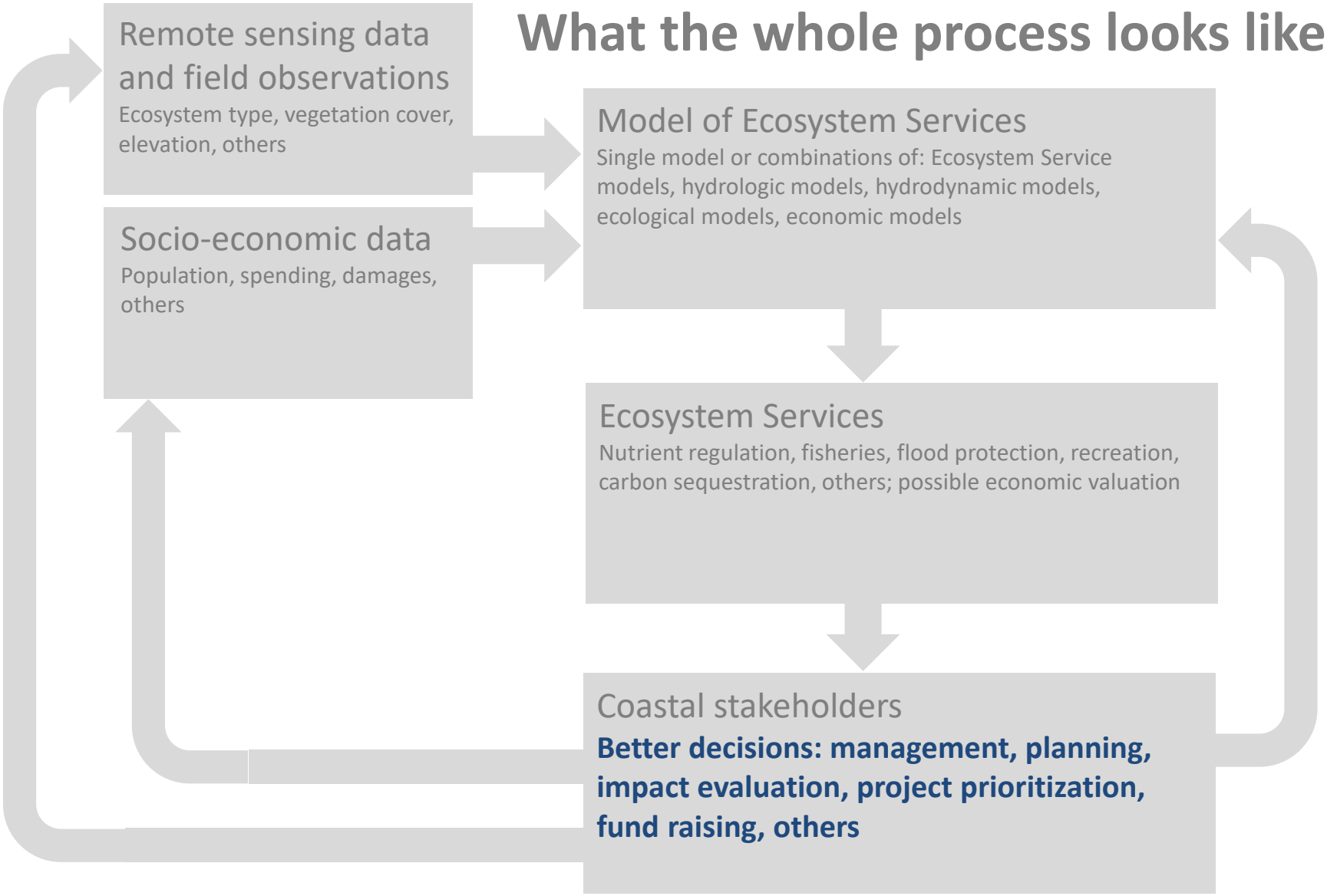


Workshop - recap



Workshop – recap

What the whole process looks like…

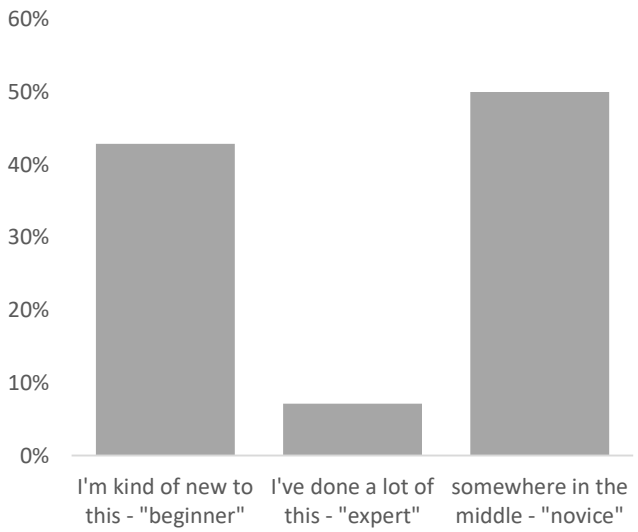


Learning from workshop participants

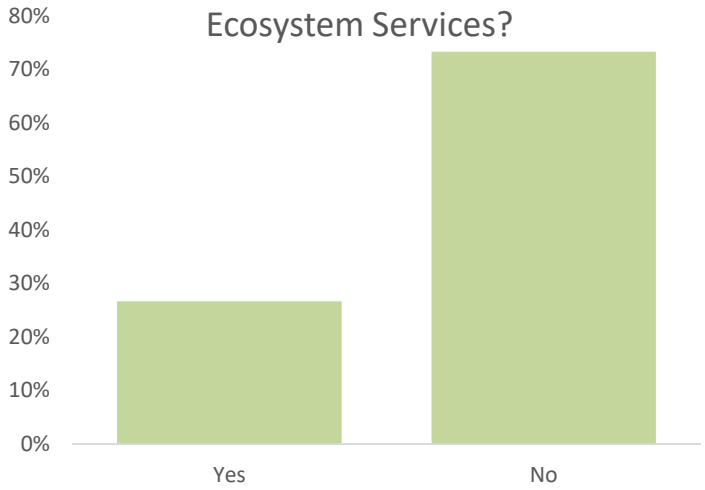
- **post-it notes, surveys, DirectPoll, discussion**

Pre-workshop surveys

Describe your experience in quantifying Ecosystem Services:



If you have some experience with Ecosystem Service assessment, did this include economic valuation of Ecosystem Services?



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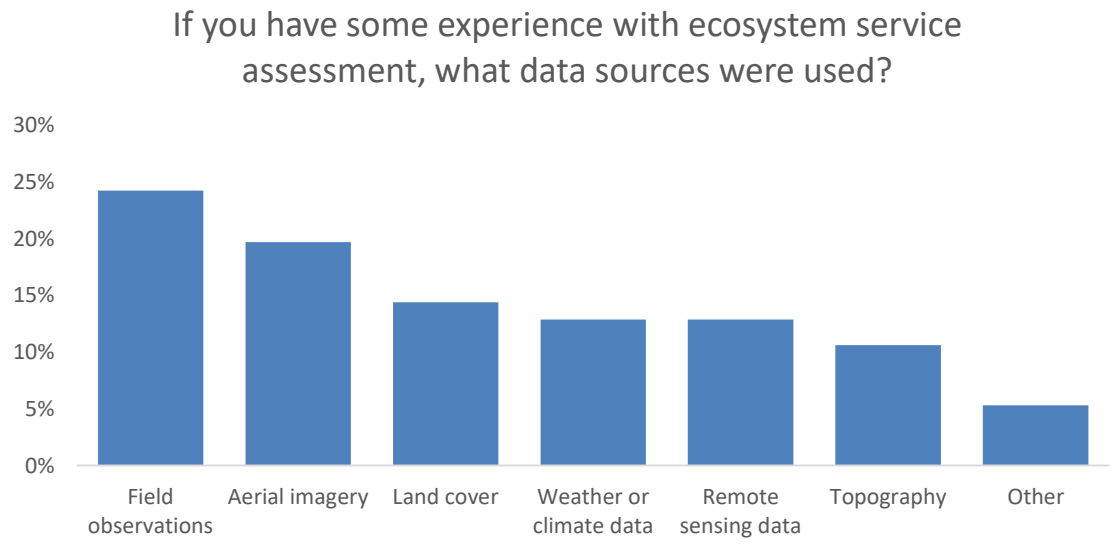
Learning from workshop participants

- **If you're doing ecosystem service assessment, what data sources are you using?**

Pre-workshop surveys



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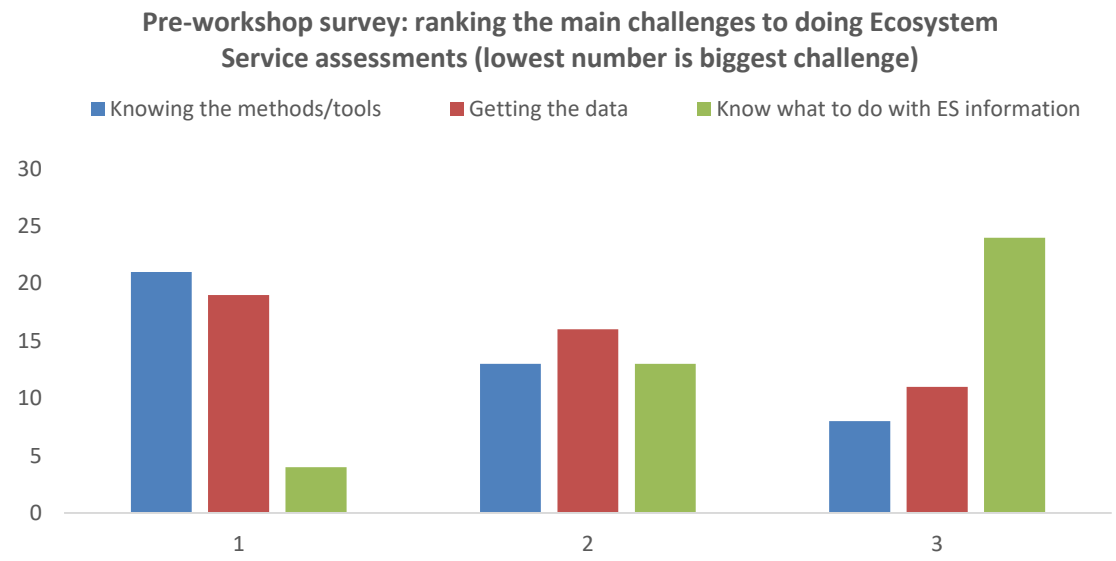
Learning from workshop participants

- **What's the biggest challenge in doing ecosystem service assessment? (Ranked)**

Pre-workshop surveys



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Learning from workshop participants

- **Good use of time?**

Post-workshop surveys

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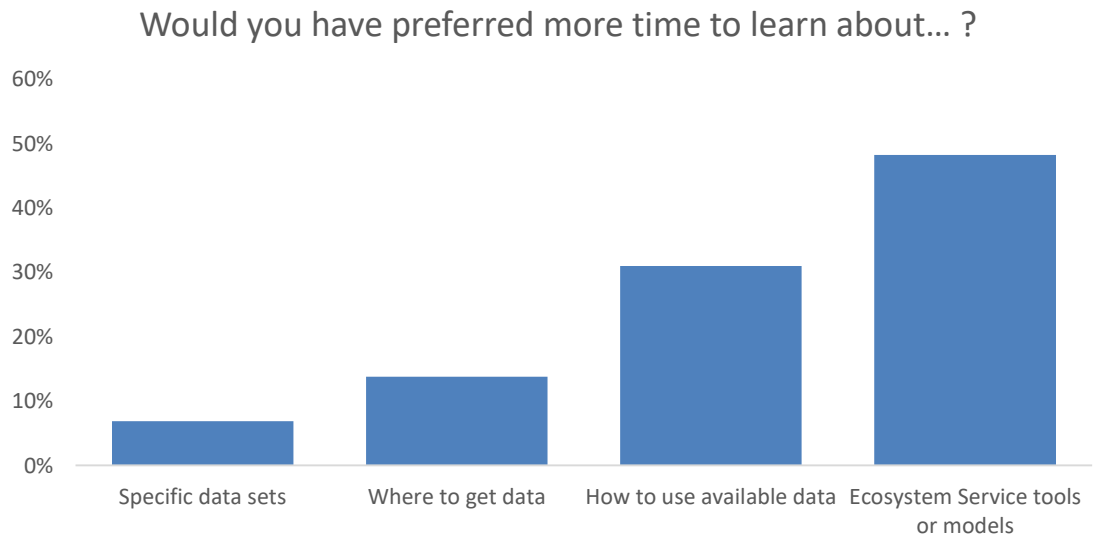
Learning from workshop participants

- **After the workshop – what would you have liked to know more about?**

Post-workshop surveys



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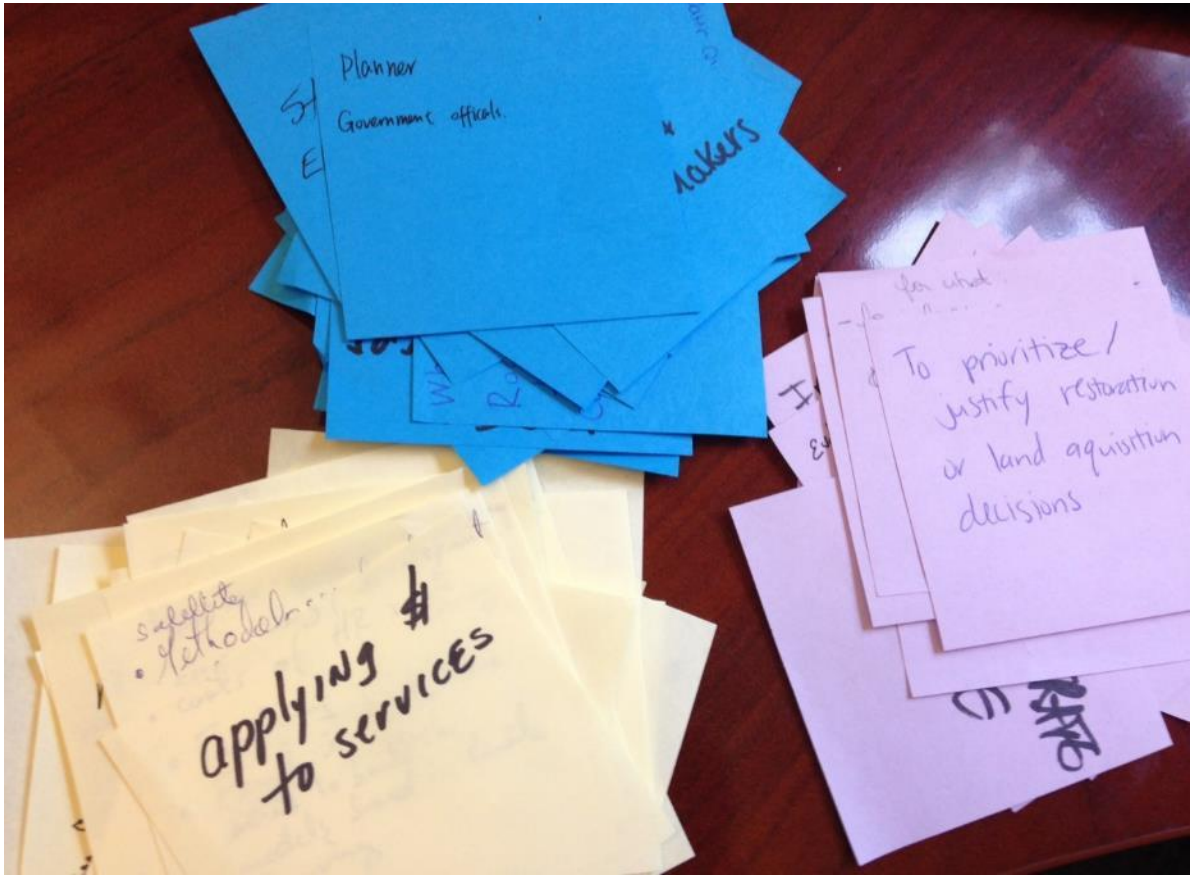
Learning from workshop participants

- **ES information? How it's used? Who it's for? Challenges?**

Post-it notes



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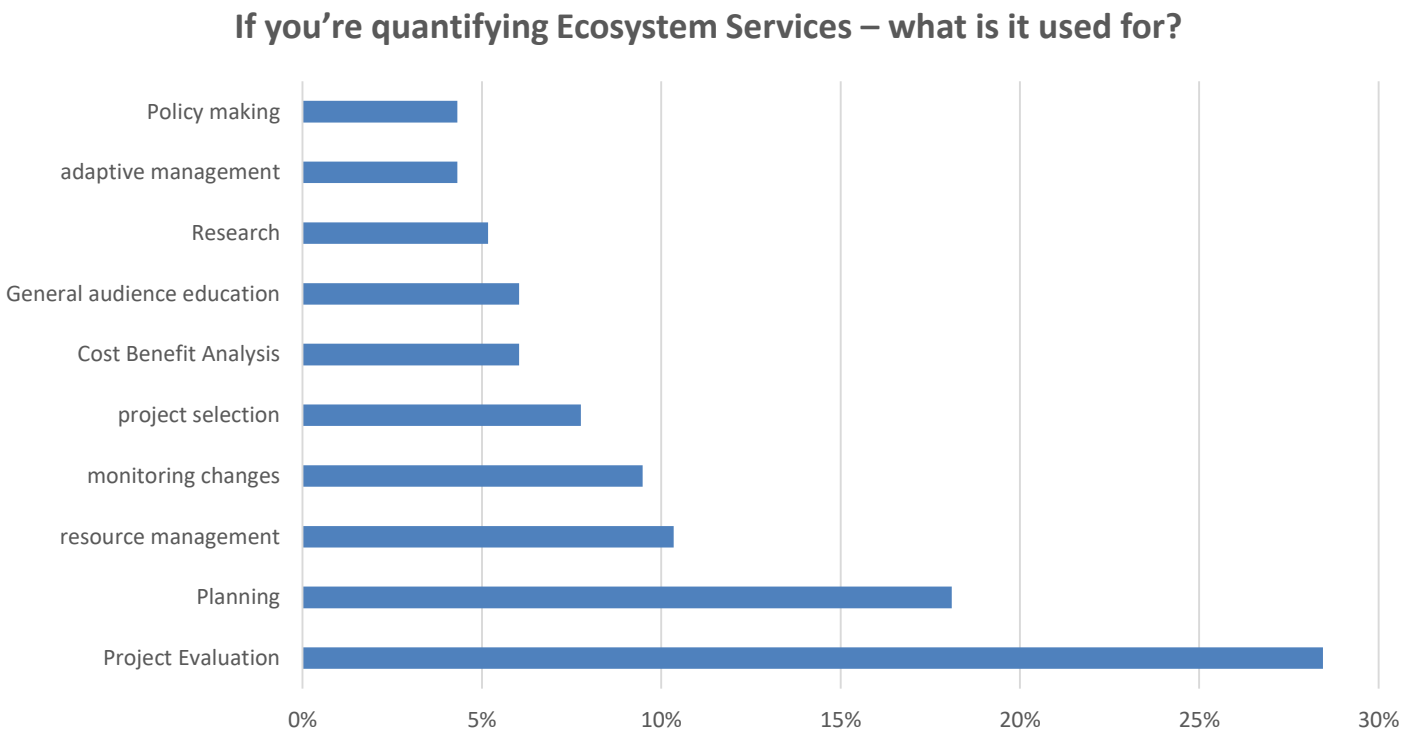
Learning from workshop participants

- **ES information? How is it used?**

Post-it notes



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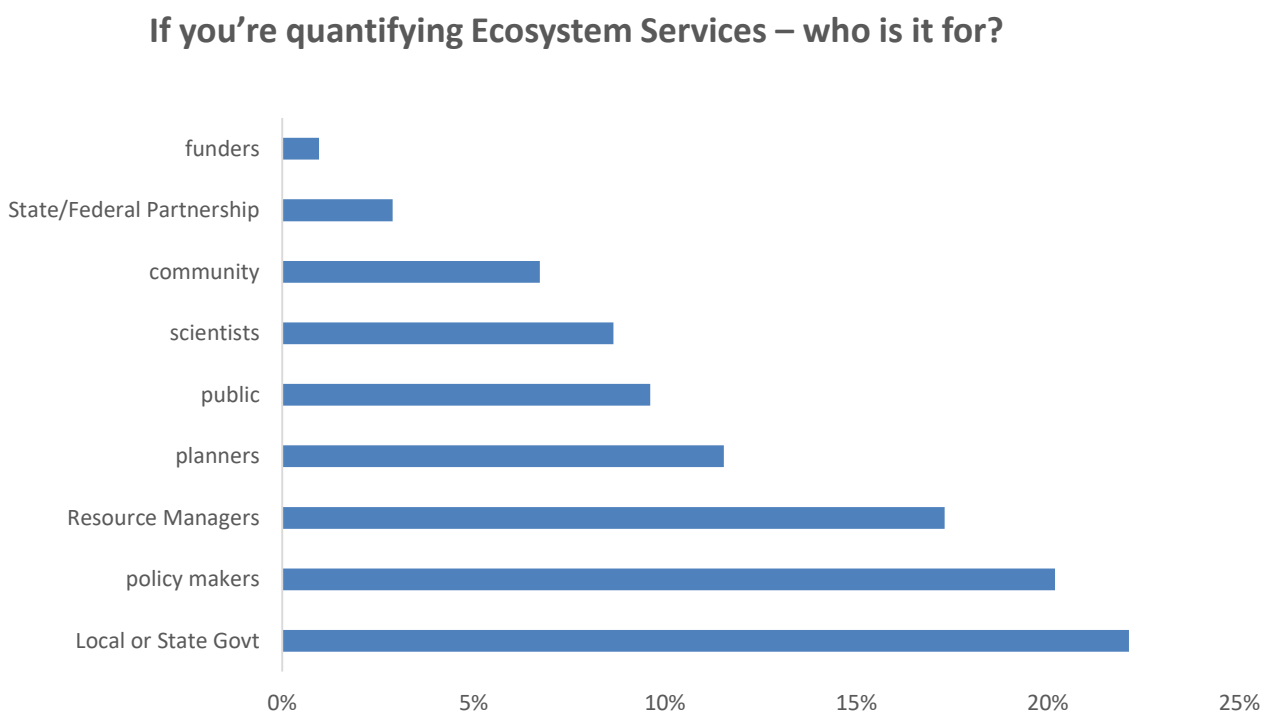
Learning from workshop participants

- **ES information? Who is it for?**

Post-it notes



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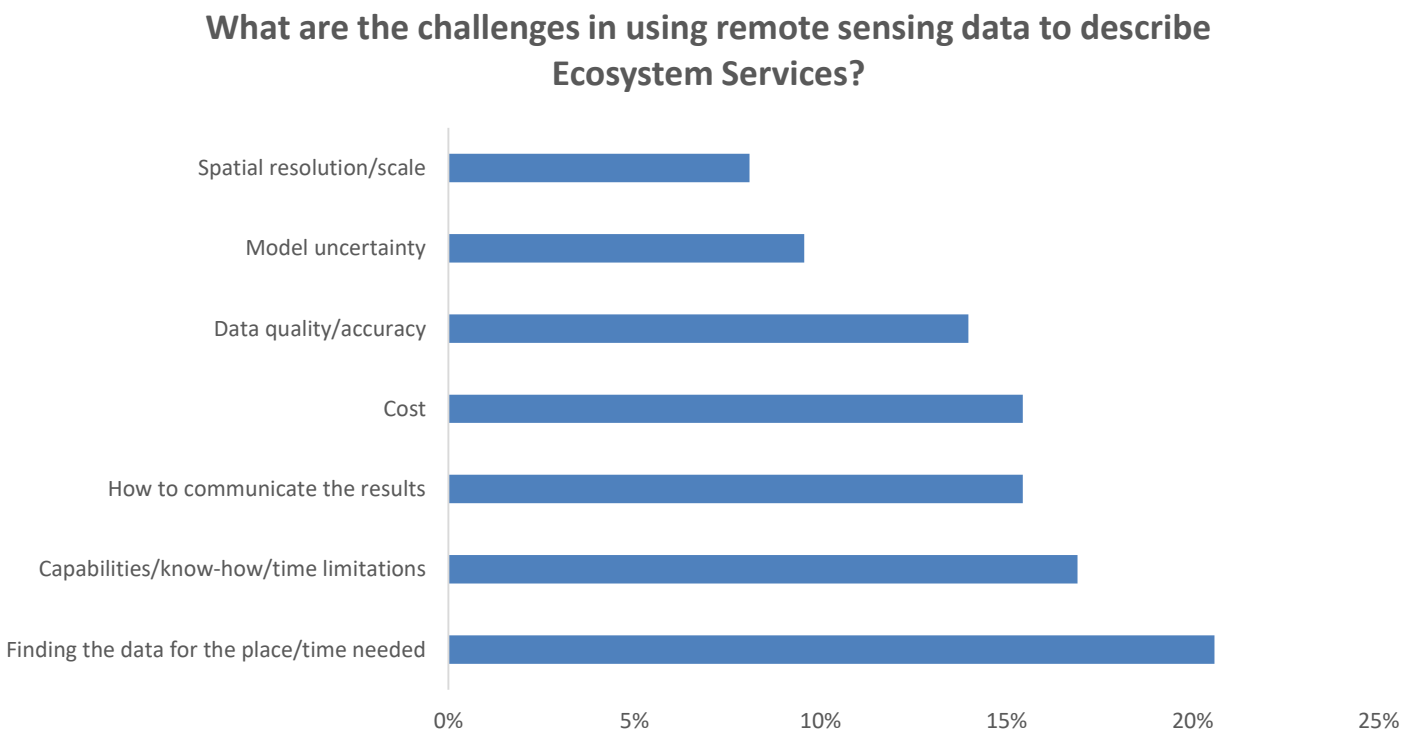
Learning from workshop participants

- **ES information? What are the challenges?**

Post-it notes



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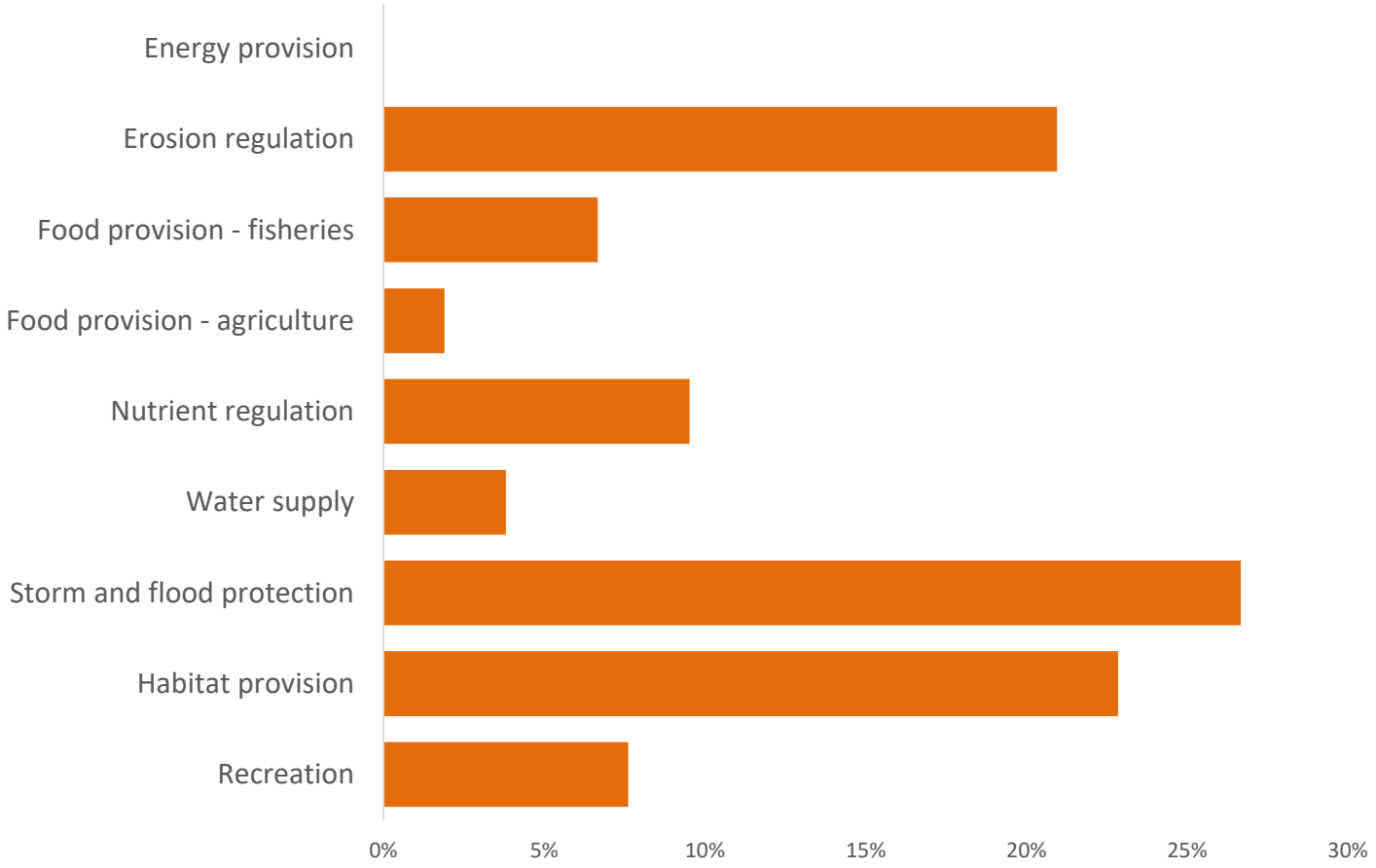
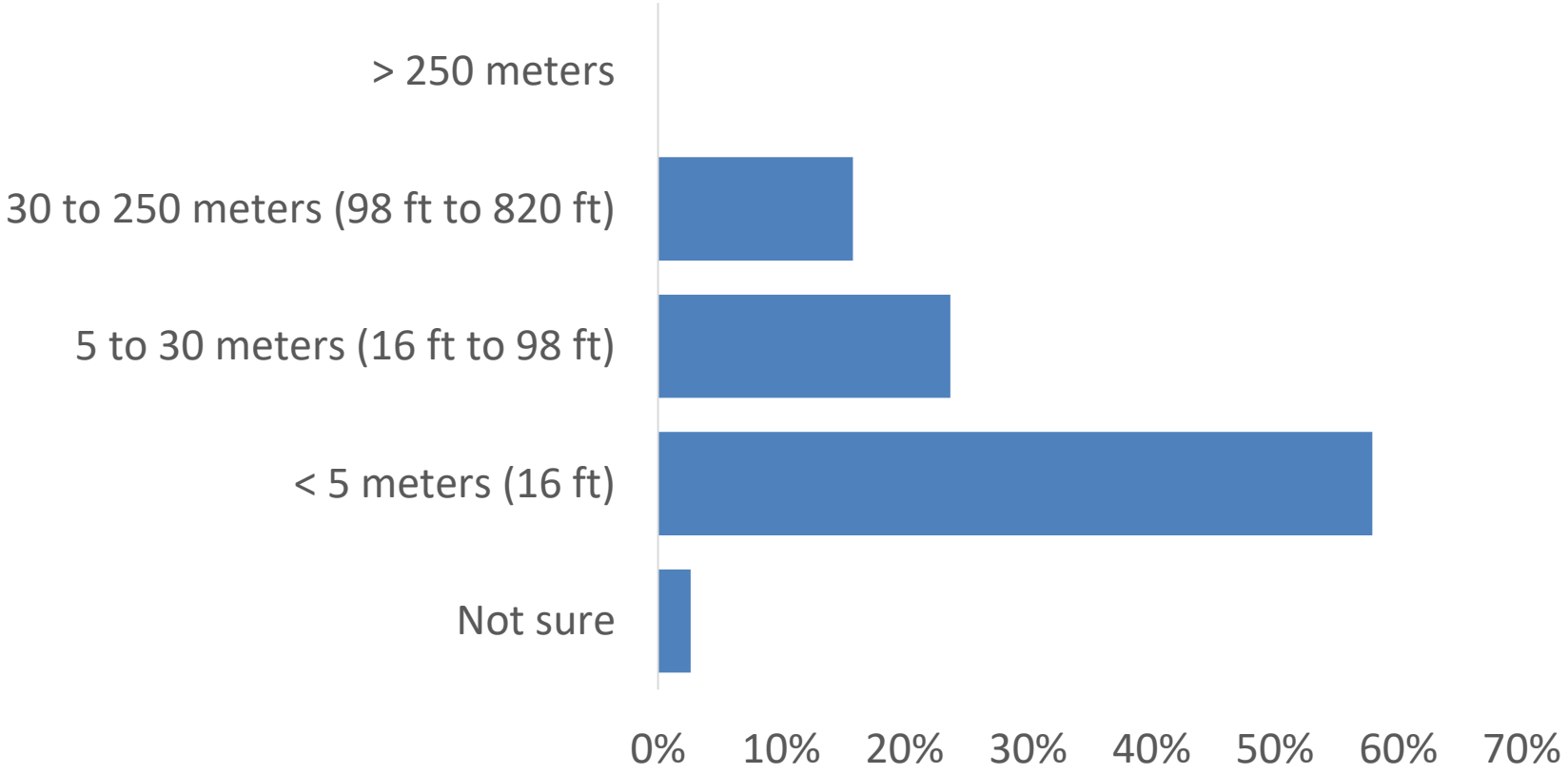
Learning from workshop participants

What ecosystem services matter most to you?



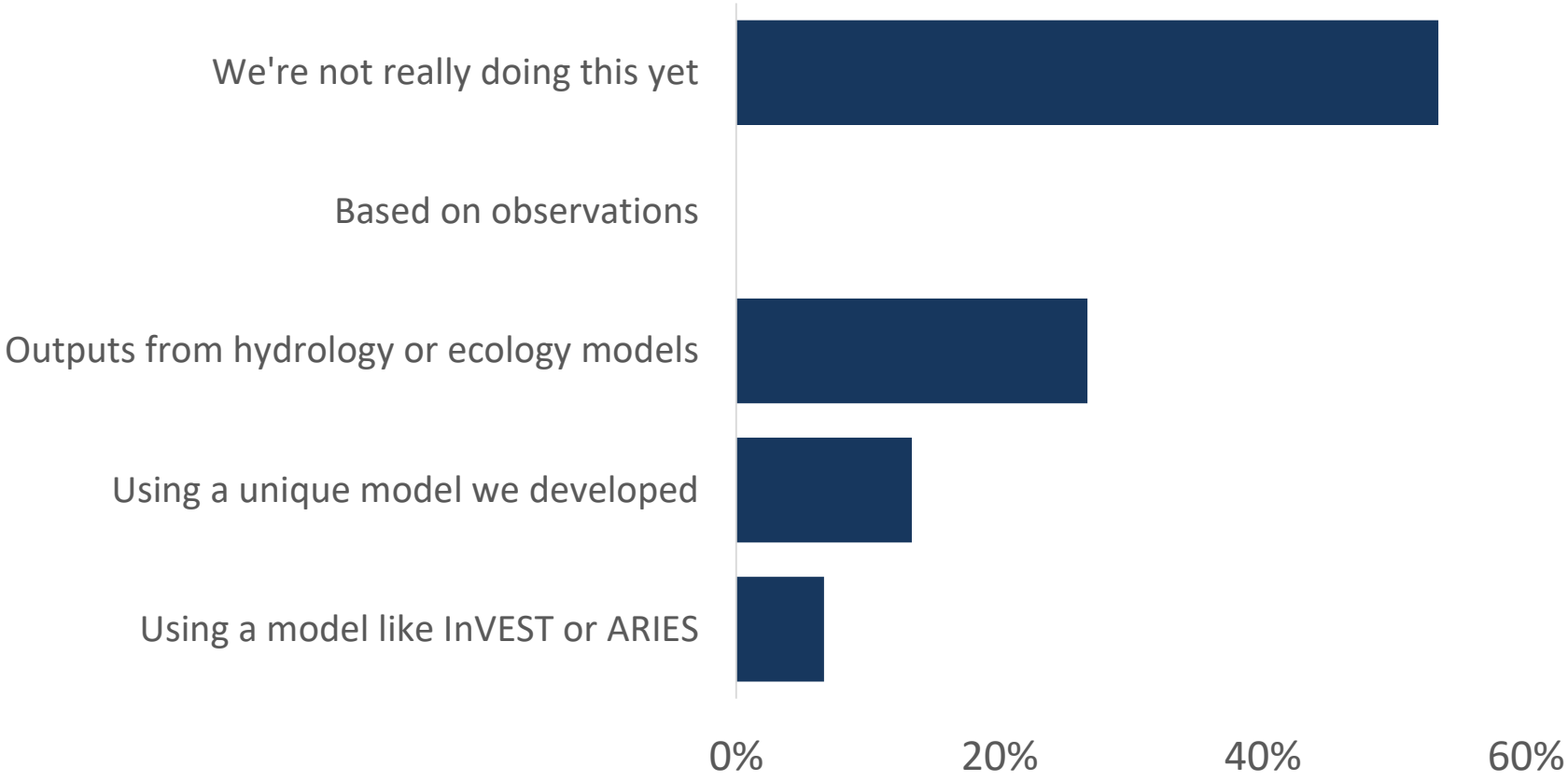
Learning from workshop participants

What is the scale or spatial resolution of the data you need?



Learning from workshop participants

How are you quantifying ecosystem services?



Learning from workshop participants

What's the most valuable thing you learned?

How to find, learn about, access remote sensing data

- "About the Giovanni and EarthData sites"
- "That there were many free options for remote sensing data"

Ecosystem Service models

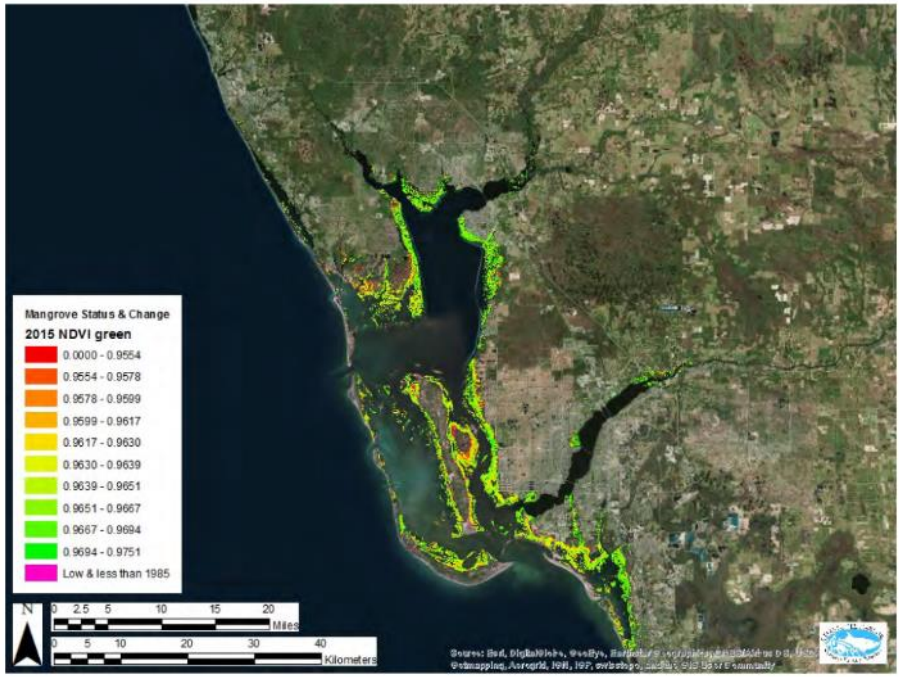
- "The free ecosystem tools (InVEST and Co$ting Nature)"
- "I learned about the ecosystem tools being used to quantify Ecosystem services "

Success stories

Gulf of Mexico: Remote Sensing and Ecosystem Service use cases

Mangrove Heart Attack: CHNEP uses Landsat 8 to manage saltwater wetlands

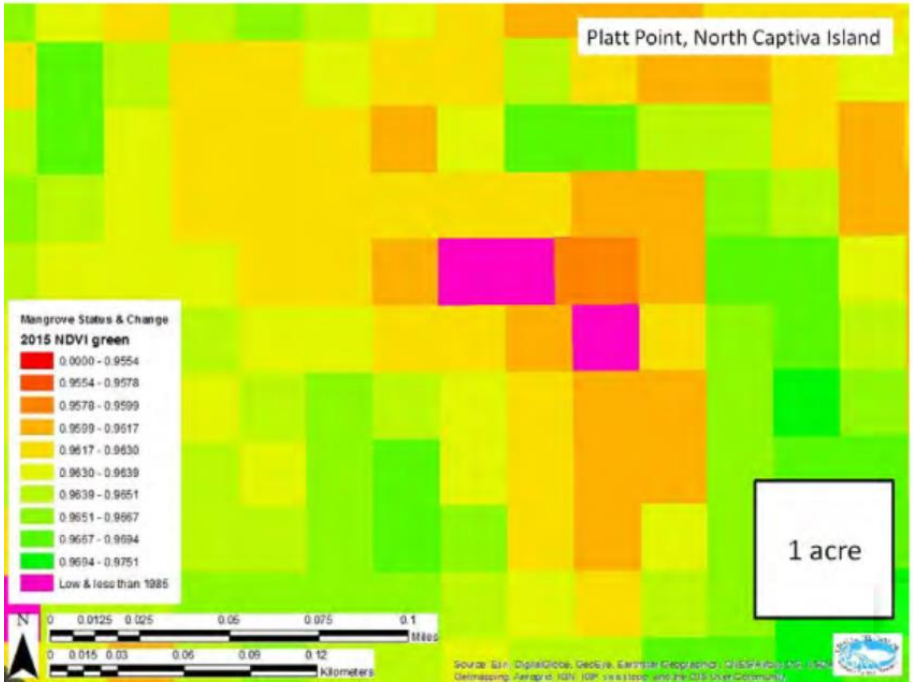
- Charlotte Harbor NEP had large mangrove mortality areas with adjacent areas showing stress and potential expansion of the die-off to thousands of acres



- Staff identified published methods to use Landsat 8 color bands/NDVI to identify mangrove health in remote locations1
  - Landsat green and near-infrared bands can be used to identify mangroves of varying conditions.
- Validated to site visits
  - 75% accuracy, same as official data used otherwise2

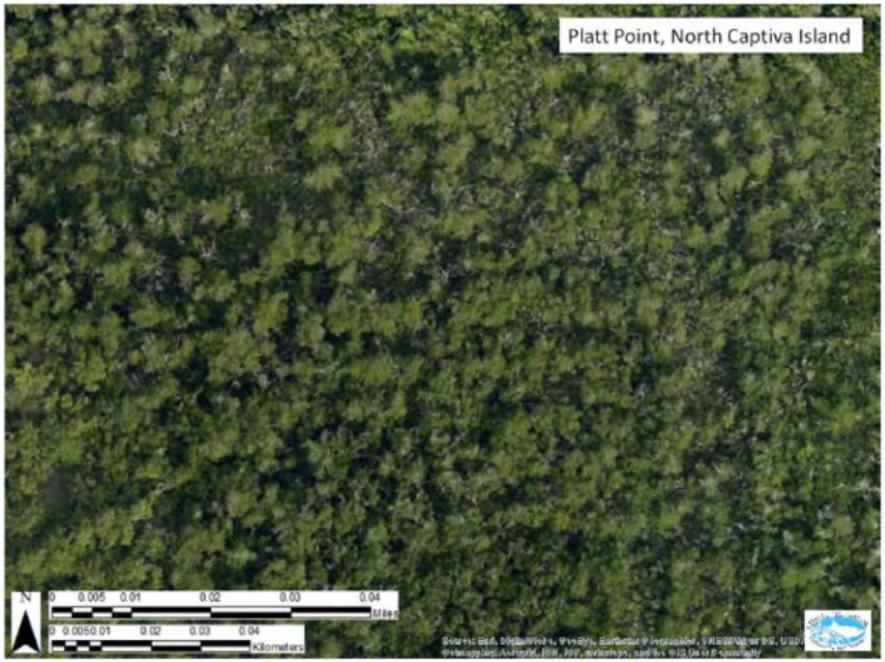
[1]Article refers to Jordan Long, Giri Chandra 2015 but no corresponding publication was located
[*]Water Management District land cover maps

Mangrove Heart Attack: using satellite data for screening tasks



- ¼ acre pixel size, but CHNEP is large area
- Areas with low NDVI green which had declined since 1985 were universe
  - Poor condition: red and orange
  - Low and declined condition: magenta
- Used NDVI Green assessment to ID declines and color coded by pixel to screen large areas
- Bright colors augmented review of forests throughout the CHNEP study area

Mangrove Heart Attack: satellite data for site level assessment

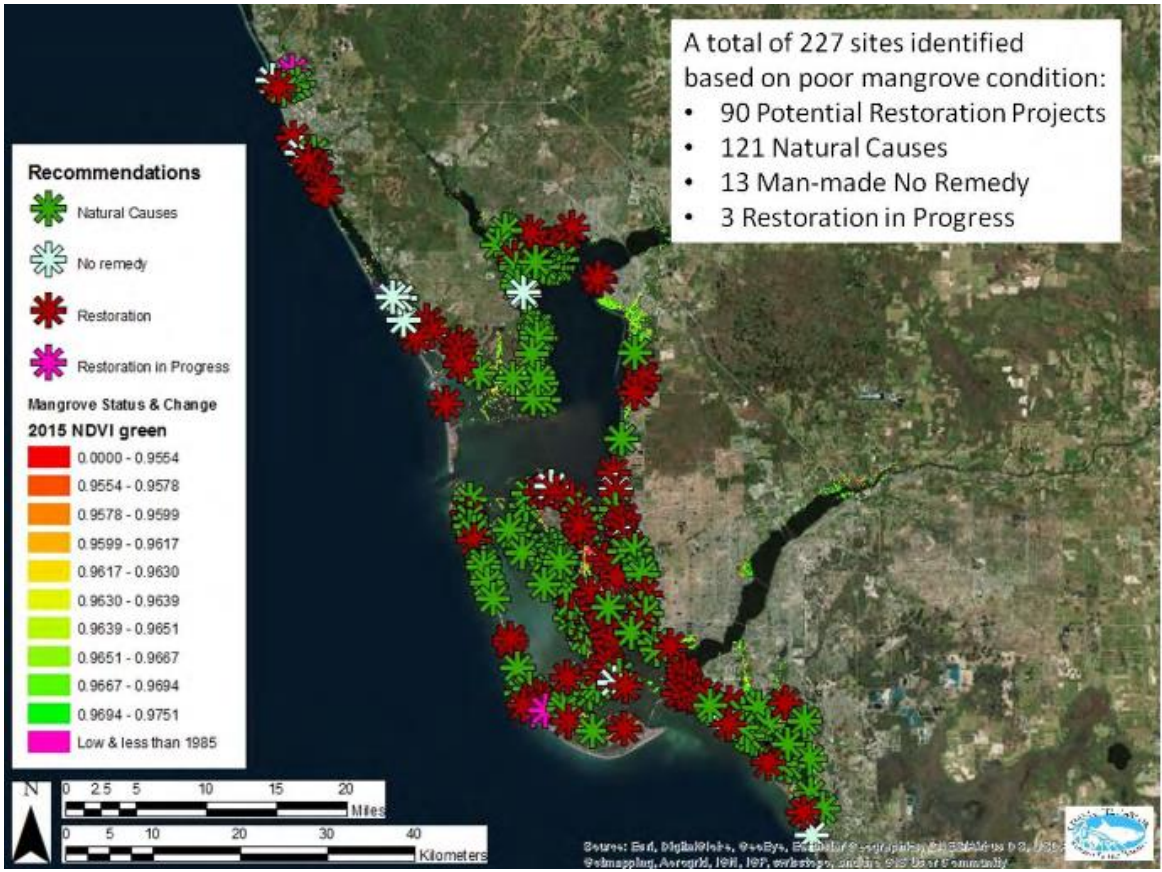


Map 37: NDVIg indicated poor condition that could be seen at 500 scale

- Evaluated health at 227 sites detected as poor
- Many areas difficult to access on site and aerials insufficient
  - At 5000 scale, some decline apparent.
  - At 1000 scale, appeared in good condition
  - At 500 scale, poor condition became apparent
  - Where low NDVIg, bare branches could be detected

Mangrove Heart Attack: converting satellite data to management action

- CHNEP found natural causes (SLR) generating many cases of mortality (121)
- Identified 90 restoration candidate sites
- 13 Man-made stressors with no NEP remedy available
- 3 sites with restoration underway



Mangrove Heart Attack: using satellite data to better manage coastal ecosystems

- Great use of existing data to evaluate trends, perform high level screening
- Good example of remote sensing data calibrated to site level inspections
- Perfect example of remote sensing data to support project decisions

Restore the Balance: TBEP applies remote sensing data to understand habitat mosaic

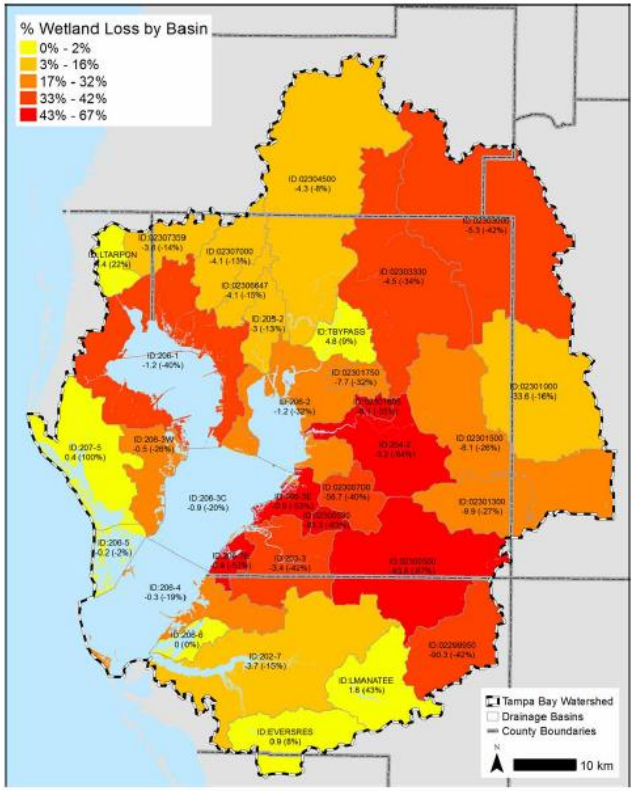


Figure 17. Wetland loss by drainage basin, 1950-2007. Categories are defined by quartile groups.

- TBEP recognized the need for a habitat mosaic approach
  - Upstream freshwater wetlands critical to certain estuarine species lifecycle
- Using historic aerials, NWI and USGS data to evaluate trends in wetland composition and build LDI (Landscape Development Intensity)
  - Changes by basin and type
- Recognizing greater percentage loss to wetlands may mean substantial change to ecosystem dynamics
  - and associated widespread consequences to ecosystem function.

Restore the Balance: using remote sensing data to identify trends and wetland condition

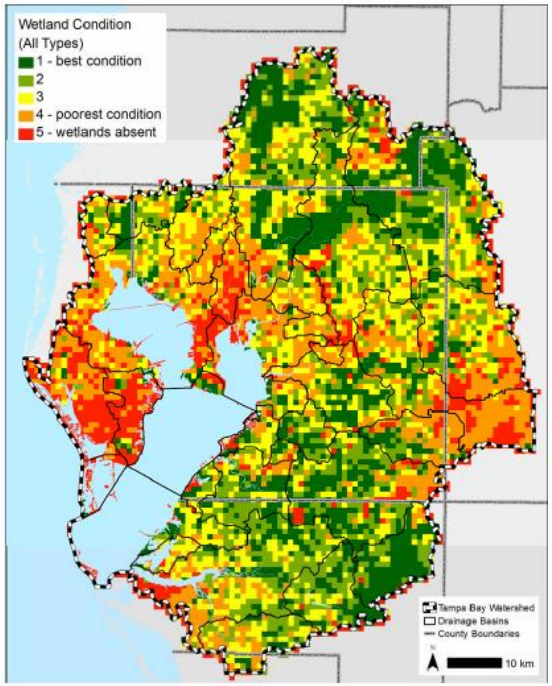


Figure 26. Screening Tool: Condition of All Wetlands.

- Calibrated LDI vs. site visit data to assess condition and vulnerability and understand types of change
  - 37 sites
- Performed conditional assessment for location and landscape support (LL), water environment (WE), and community structure (CS).
  - ½ acre accuracy
  - R^2 = .69
  - Consistent with Florida rules

Restore the Balance: using remote sensing data to identify vulnerabilities

- Coastal ecosystem services included nutrient reduction and regulation, water supply, and flood attenuation
- For setting wetland-level priorities of restoration, preservation or mitigation, several measures were provided
  - Wetland change (by type and function)
  - Conditional assessment
  - Hydrologic connectivity to bay
  - Economic vulnerability

Table 7. Type of change at the scale of individual wetlands.

Type of Change	Area (km^2)	% of all Change
Structural Change	73.1	7.5%
Hydrologic Change	58.5	6.0%
Change to both Structure and Hydrology	14.9	1.5%
Total Change in Structure or Hydrology	**146.5**	**15.2%**
Wetland Loss	**622.7**	**63.8%**
Wetland Gain	**206.7**	**21.2%**
Total Individual Wetland Change	**975.9**	**100%**

Restore the Balance: using remote sensing data to better manage coastal ecosystems

- **Transactionally**, permitting decisions reference the output to achieve regional goals one wetland at a time[1]
- Permitting agencies adopted the historical condition and overall prioritization plan into their rules
  - Because historic condition is cited
- **Regionally,** habitat master plan is part of setting restoration targets for update to CCMP

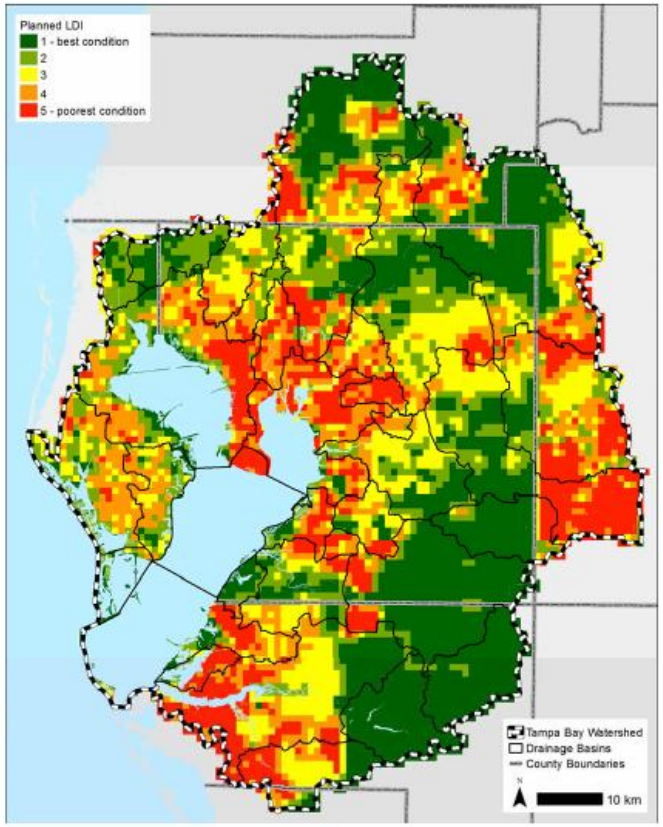


Figure 34. Screening tool: Planned Development Impact (LDI).

[1] SAV only

Restore the Balance: Challenges & opportunities to coastal ecosystems valuations

Challenge

- Separate ecosystem services studies came out in metro area at the time
  - Blue Carbon 2011: assessed Carbon storage values of seagrass, mangroves, marshes and salt marshes as SLR occurs through 2100
  - City of Tampa Tree canopy study used ecosystem values[1]
- Opens ES values to scrutiny
  - Included invasive with high carbon storage

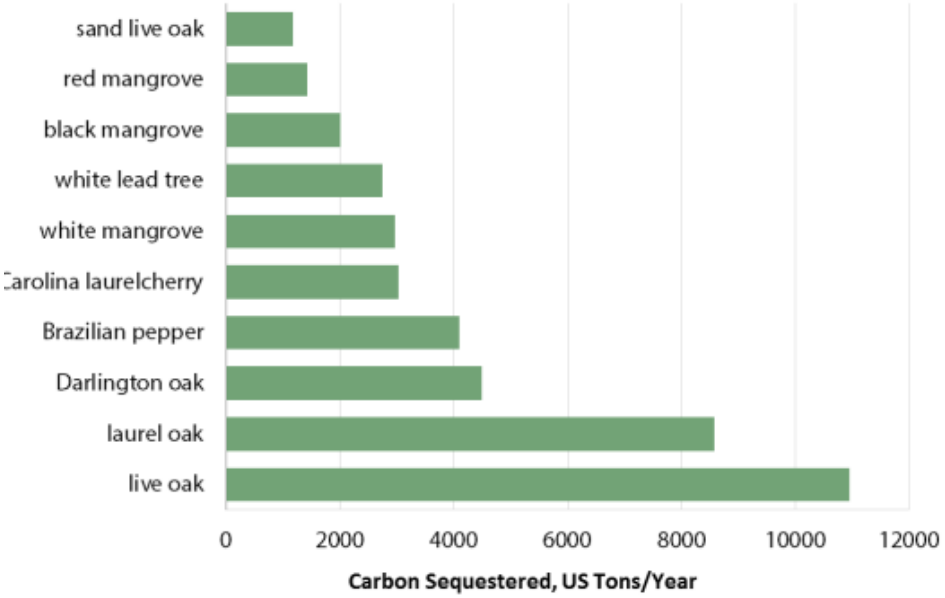


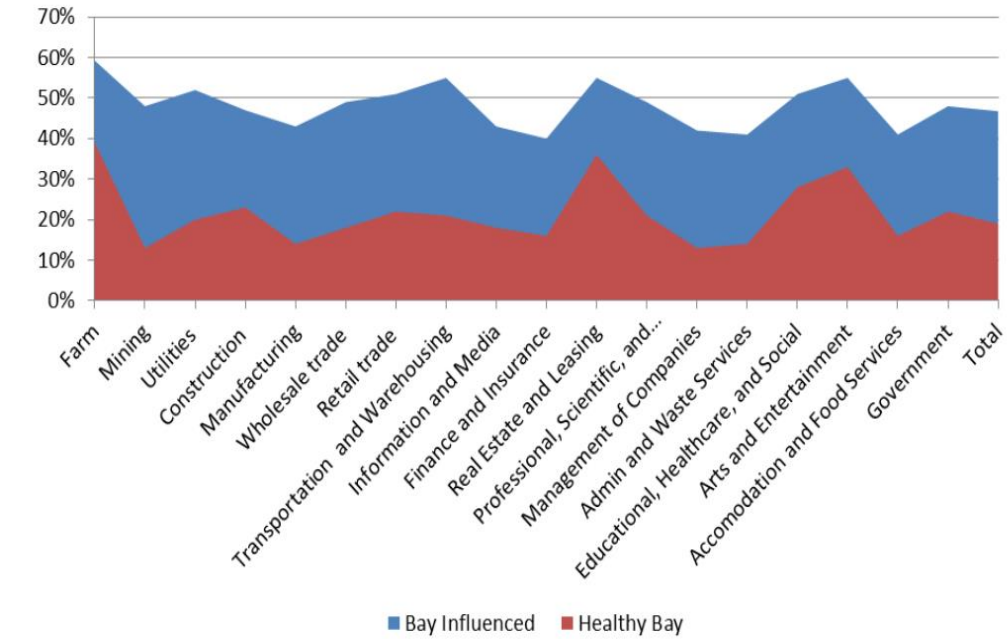
Figure 37. Annual rate of carbon (C) sequestered by species, 2011

[1]Landry et al 2012

Restore the Balance: Challenges & opportunities to coastal ecosystems valuations

Opportunity

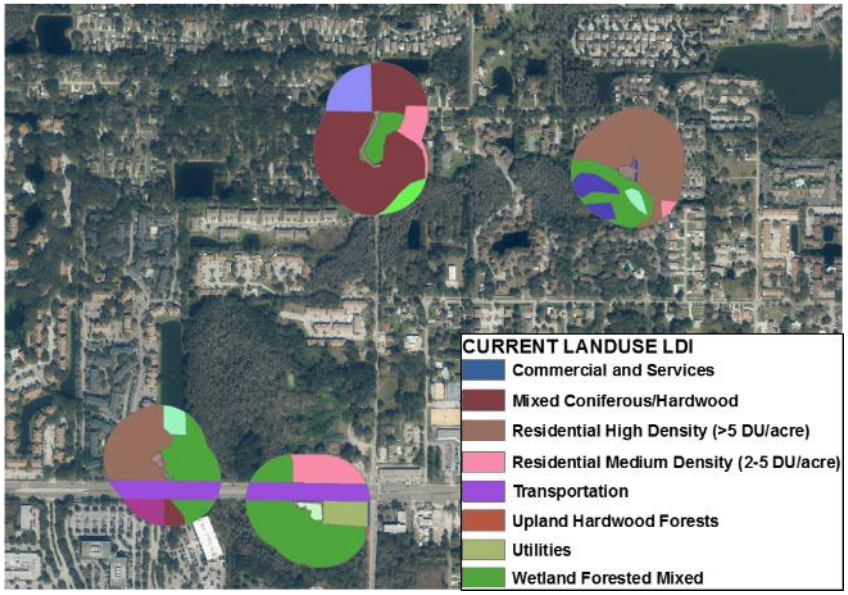
- ESV study found $22 million/year in avoided wastewater treatment costs[1]
- ESV/REMI study gained major coverage in business community[2]
  - 300,000 jobs, $20 billion in business
    revenues dependent on healthy bay



[1]Russell/Greening [2] TBCRPC

Constructed wetland success: satellite data for site level assessment and comparison

Landscape Development Intensity (LDI) Analysis



- SWFWMD assessed LDI for surrounding land uses of natural and constructed wetlands
- At the site scale, LDI shows a strong negative correlation to wetland biodiversity, water quality, and UMAM scores. At the regional scale, LDI can be used to identify hotspots for development or locate low-LDI areas that may be candidates for preservation.

Next steps

How to start using remote sensing information for better coastal management and planning

Next Steps

remote sensing for better coastal management and planning

Answer these two questions first:

1) What are your goals?

Example goals of a project or program or agency

PROJECT GOALS	
ECOLOGICAL GOALS	SOCIOECONOMIC GOALS
• Erosion control • Water quality • Habitat • Hydrological enhancement	• Community resilience • Cultural values • Economic development • Recreation • Water quality

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2) What actions are you trying to improve?

- Policy: zoning or land use regulating
- Prioritizing investments: restoration, land acquisition, others
- Education of general public
- Raising funding

Next Steps

remote sensing for better coastal management and planning

What ecosystem information do you need to improve management or planning?

What ecosystems? Which ecosystem services or indicators are relevant?

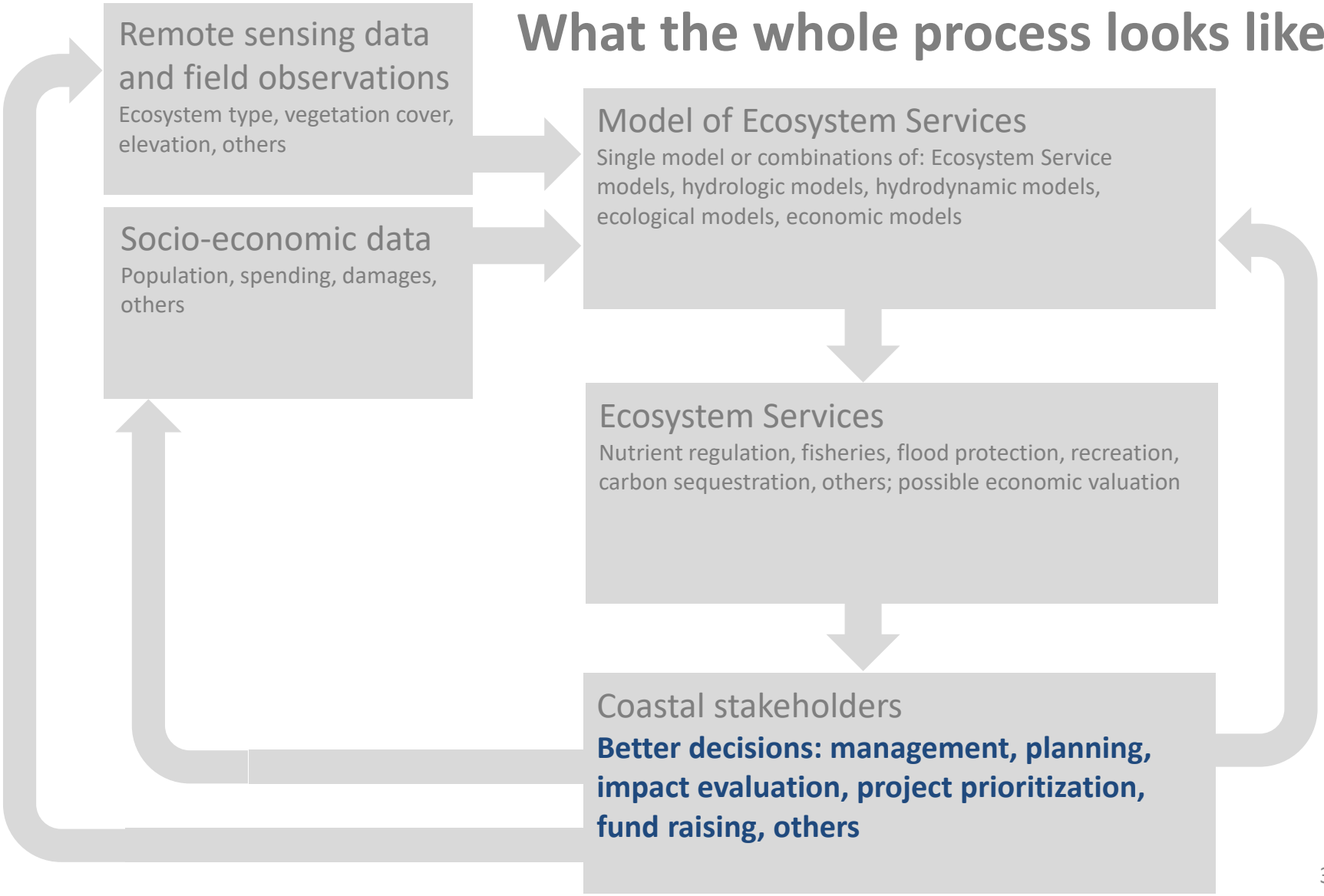
- To raise awareness or influence policy… you might actually need to quantify particular ecosystem services or some bundle of services (and possibly $ value)

- To evaluate project impact: it might be sufficient to know ecosystem extent (area) and/or ecosystem health (vegetation index, connectivity)

Next Steps

remote sensing for better coastal management and planning

What the whole process looks like…



Next Steps

remote sensing for better coastal management and planning

Getting started

Remote sensing data and field observations

Ecosystem type, vegetation cover, elevation, others

Ecosystem health or extent

Leverage field data with remote sensing: to see a bigger area, to have more temporal extent

Coastal stakeholders

Better decisions: management, planning, impact evaluation, project prioritization, fund raising, others

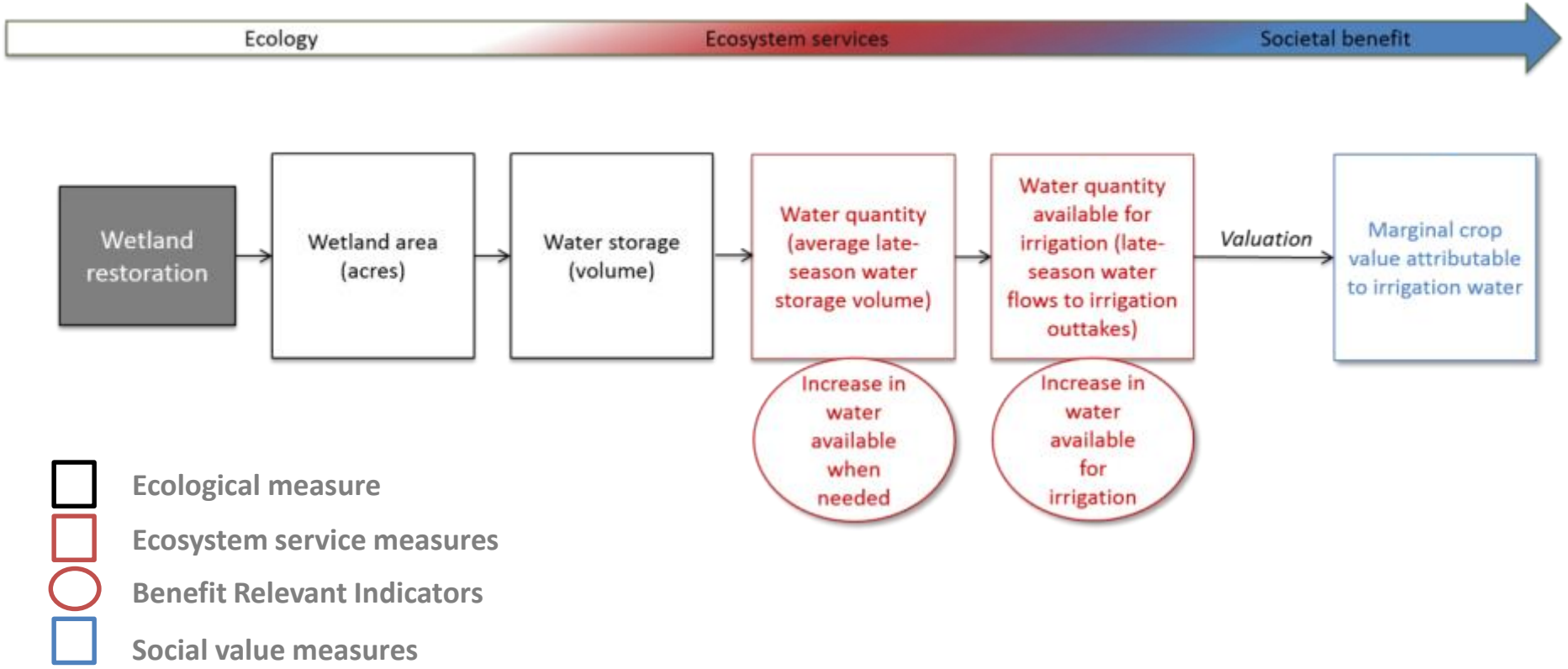
How remote sensing data can help:

- 'extending your observations' to see changes at times or places where you don't have measurements
- Continue a monitoring program at lower cost

Next Steps

remote sensing for better coastal management and planning

Continuum from ecological impact to ecosystem service to societal benefit:

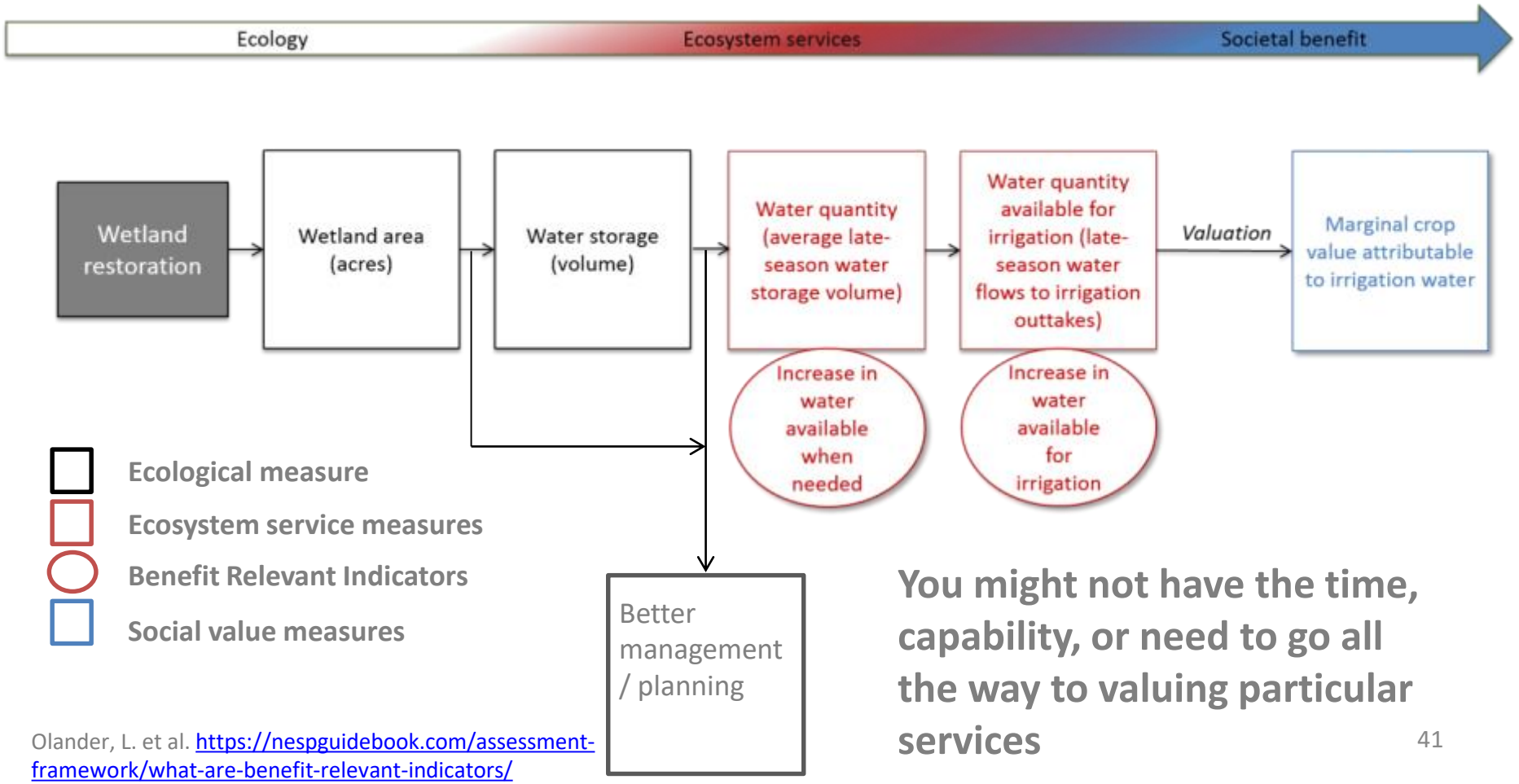


Olander, L. et al. https://nespguidebook.com/assessment-framework/what-are-benefit-relevant-indicators/

Next Steps

remote sensing for better coastal management and planning

Stepping off the continuum when it makes the most sense for your goals:



You might not have the time, capability, or need to go all the way to valuing particular services

Olander, L. et al. https://nespguidebook.com/assessment-framework/what-are-benefit-relevant-indicators/

Next Steps

remote sensing for better coastal management and planning

Learning more:

About remote sensing data…

- NASA's **ARSET** (Applied Remote Sensing Training)
- https://arset.gsfc.nasa.gov/webinars/fundamentals-remote-sensing
- "The ARSET program offers satellite remote sensing training that builds the skills to integrate NASA Earth Science data into an agency's decision-making activities"

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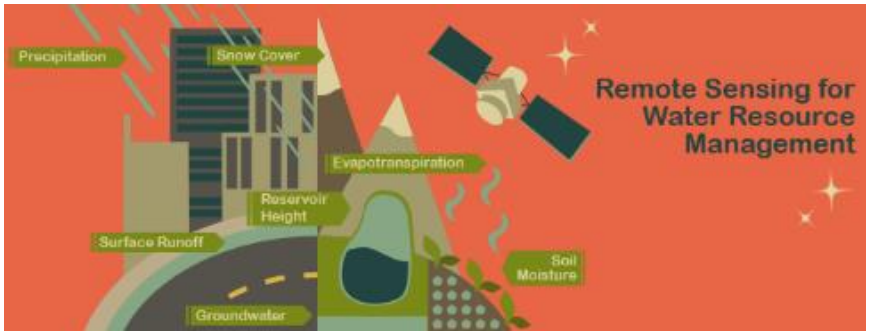


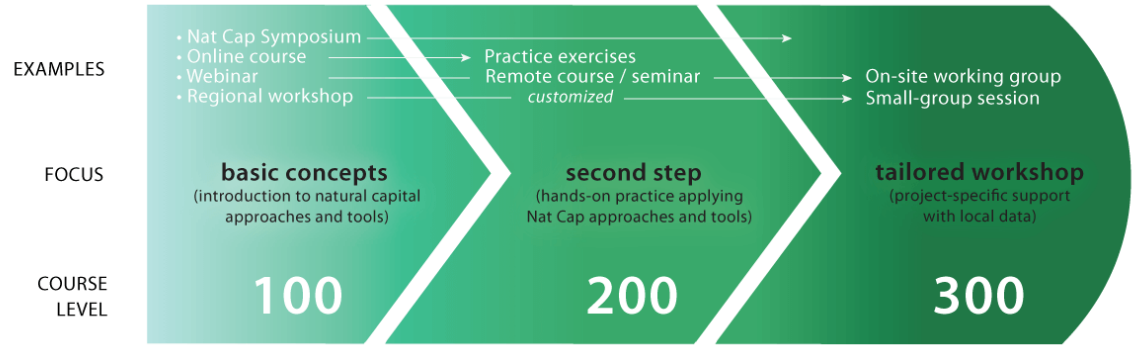
Next Steps

remote sensing for better coastal management and planning

Learning more:

About ecosystem service models…

- **InVEST**



InVEST

integrated valuation of ecosystem services and tradeoffs

- https://naturalcapitalproject.stanford.edu/invest/#resources

- **ARIES** (ARtificial Intelligence for Ecosystem Services)
- http://aries.integratedmodelling.org/?page_id=940

Next Steps

remote sensing for better coastal management and planning

Summary of next steps…

1) What are your goals?/ What actions are you trying to improve?
2) What ecosystem information is needed?
3) Get the training needed to fill any capabilities gaps

Thank you!

Contact

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