# Carbon Management in Coastal Wetlands: A collaborative approach to quantifying GHG flux to support development of a GHG protocol and economic assessment

**Funded by the NERRS Science Collaborative**

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NOAA National Oceanic and Atmospheric Administration U.S. Department of Commerce

National Estuarine Research Reserve System Science Collaborative

University of New Hampshire

MBL Biological Discovery in Woods Hole

Restore America's Estuaries

Manomet Center for Conservation Sciences

Waquoit Bay National Estuarine Research Reserve

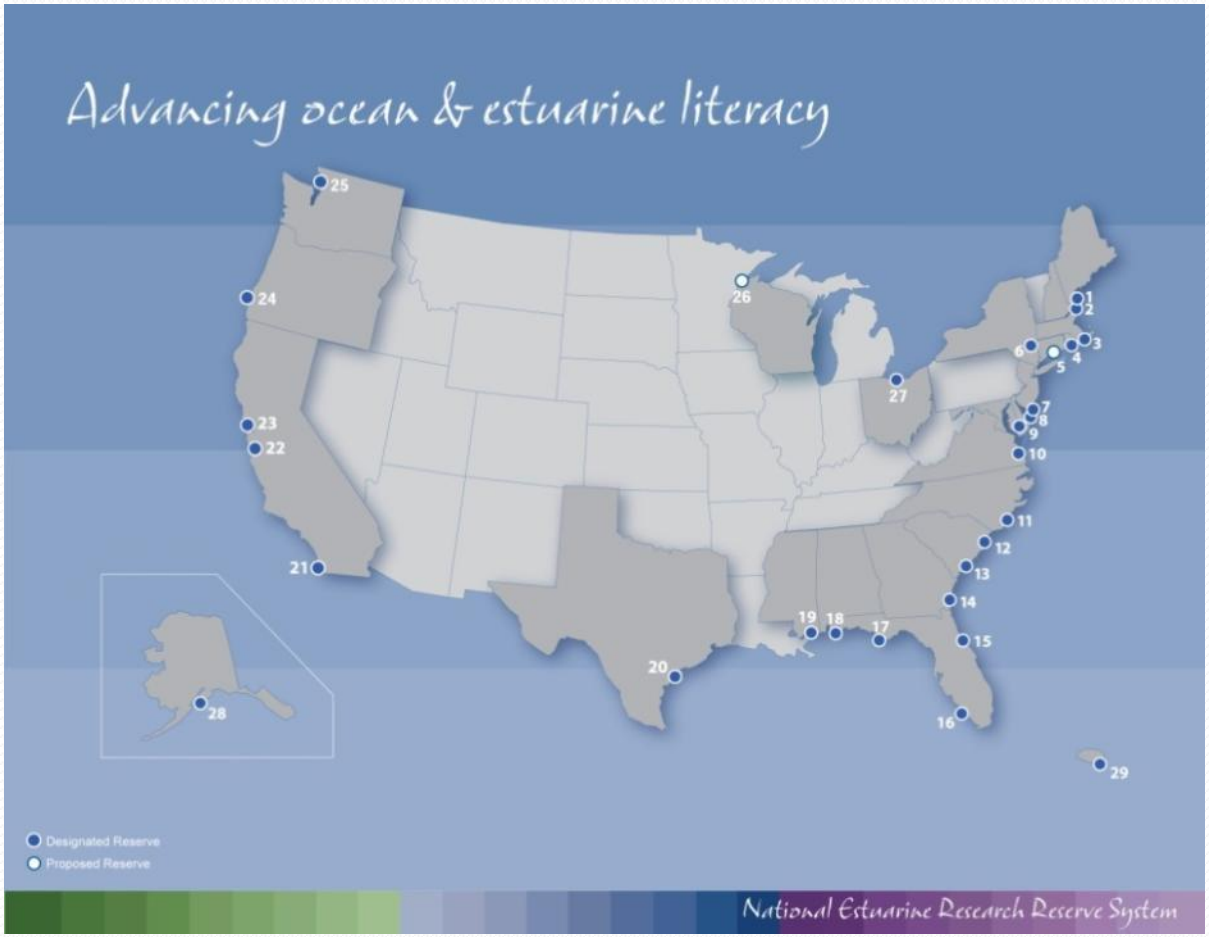
The University of Rhode Island Think Big We Do

USGS science for a changing world

FIU Florida International University

# WBNERR is one of 28 NERRs around the coast

## Mission: to promote science-based decision-making that leads to clean coastal waters



# NERRS Science Collaborative projects must:

- Be NERR-driven
- Address priority coastal management issues for that Reserve's region
- Involve scientists and stakeholders/end-users collaborating* from the outset

* "By *collaboration*, we mean an explicit and justified plan for the interaction of applied scientists and the intended users of science throughout a research project."

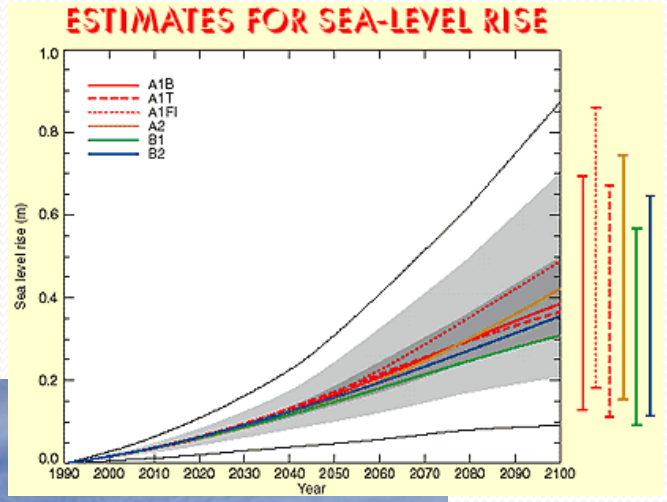
NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM SCIENCE COLLABORATIVE

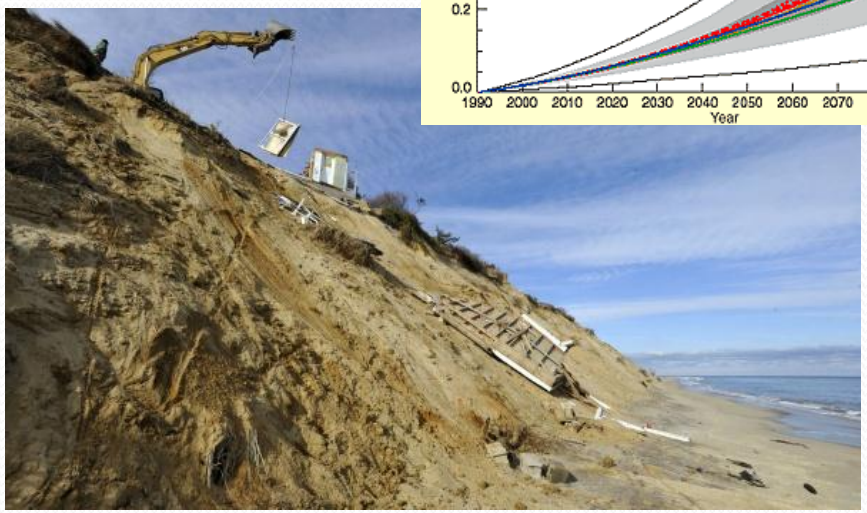
# Reasons

- When intended users are part of the research process… They become more aware of the science;
- The science focuses on questions that are a high priority for them;
- Their knowledge informs and enriches the science;
- The scientific knowledge generated by the project is practical and useful to them;
- They trust the science.

# Background of this project

- Climate change and nitrogen loading among most pressing coastal concerns in northeast US



- Greenhouse gases (GHG) main drivers of CC
- One approach to reducing GHG is protection and restoration of ecosystems that store them
- "Green carbon" – terrestrial – well-known. International C markets can help fund preservation or restoration of forests because:
  - Research has quantified how much C forests sequester.
  - ***Methodologies*** have been developed which turn those sequestration rates into C offset credits for a project.

There is potential to use this strategy to fund coastal wetland conservation or restoration, but:

- There is  no Methodology for coastal wetlands because
- There is not enough understanding of GHG sequestration rates in these ecosystems
- There is not a user-friendly way to estimate rates or value

# Why Wetlands Carbon?

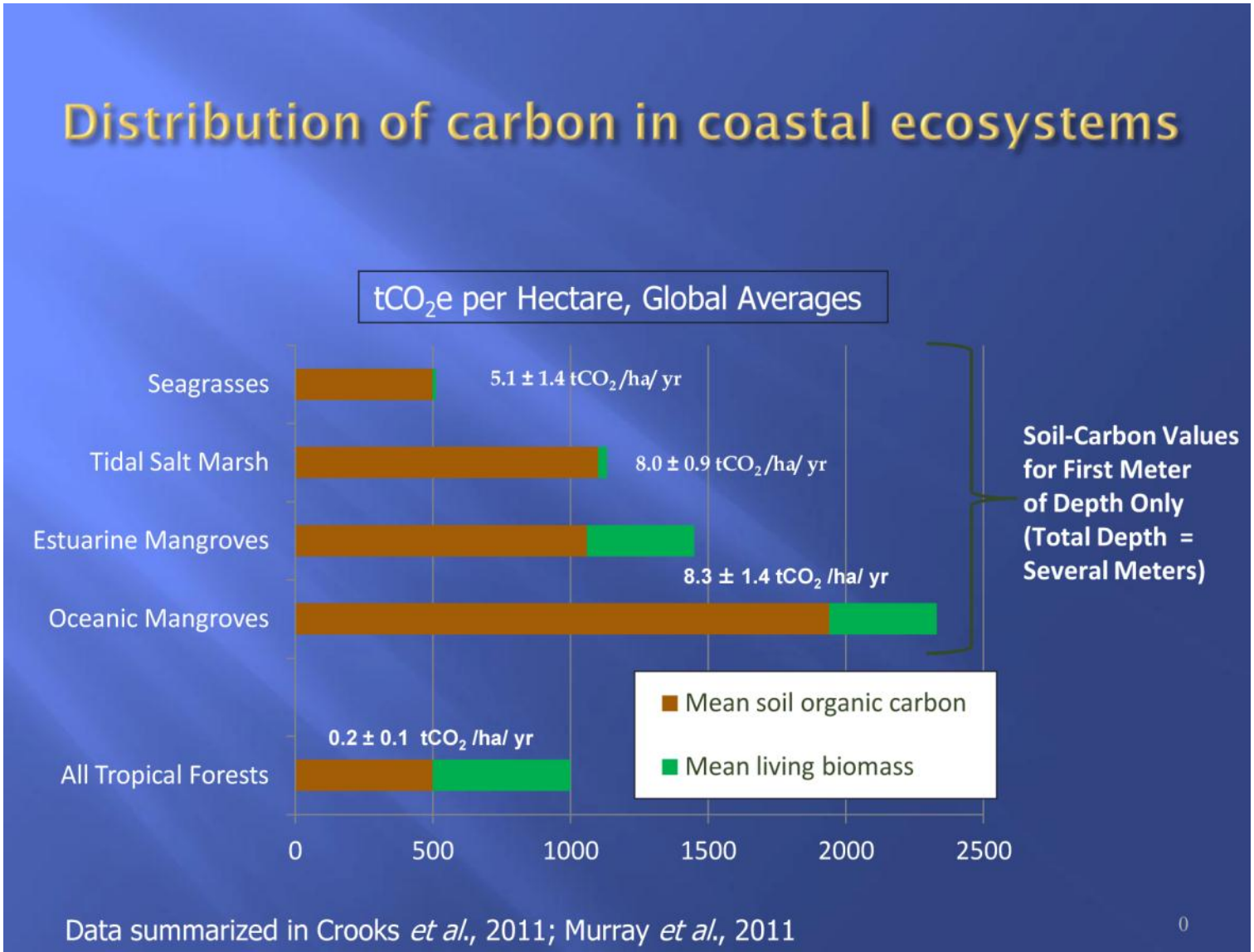
- Benefits of healthy estuaries and restoration
- Coastal wetland loss and degradation
- Demand for restoration
- Carbon storage and sequestration
- Climate adaptation and mitigation

RESTORE AMERICA'S ESTUARIES

Slide courtesy of Steve Emmett-Mattox

# What we *do* know

- Salt marshes store large quantities of GHG – so-called "*Blue Carbon*"




Slide courtesy of Steve Crooks

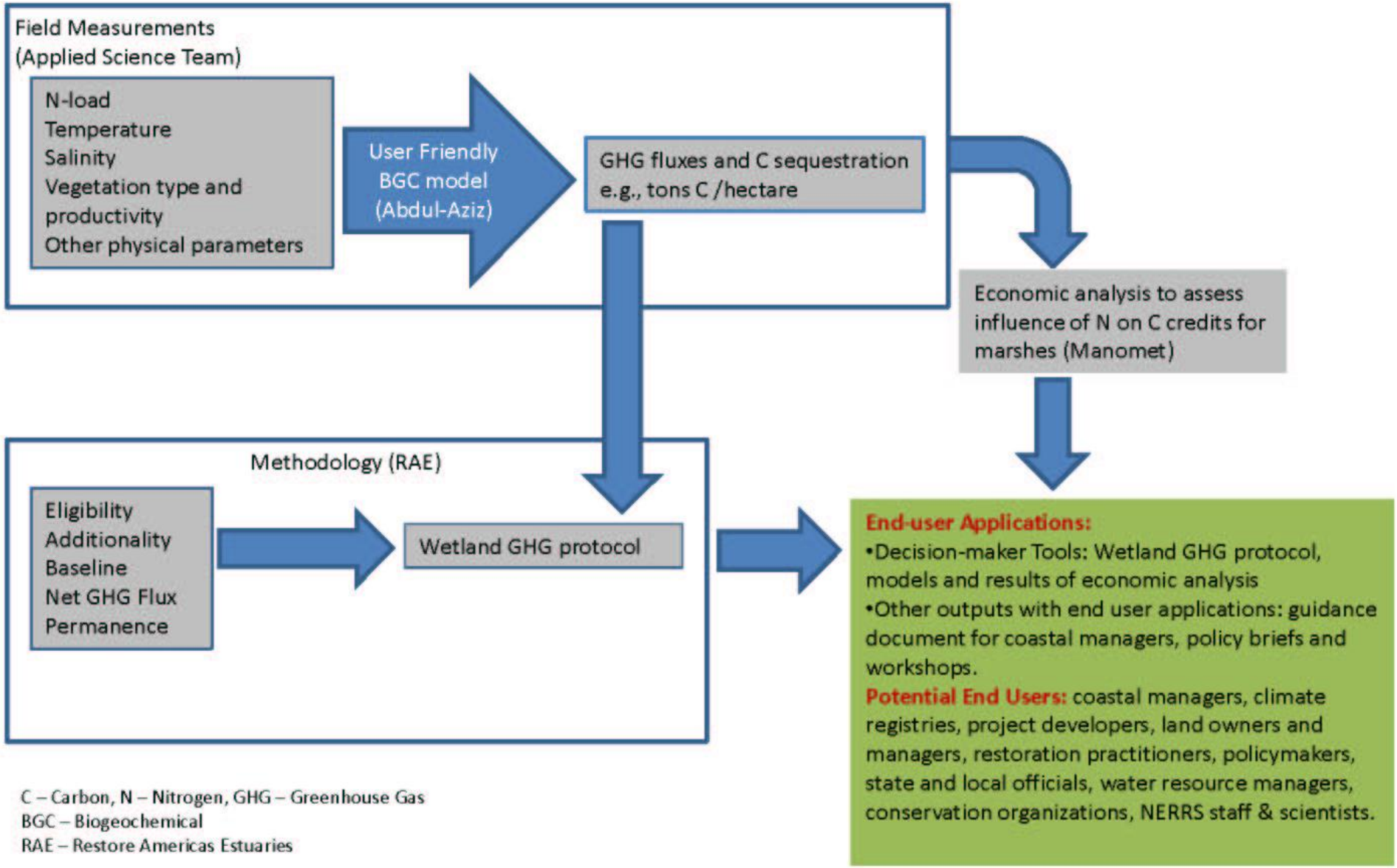
- Evidence that N in salt marshes leads to:
  - nitrous oxide ($N_2O$) emission
  - less root mass (and less C storage)
  - switch from carbon "sink" to "source," exacerbating CC rather than mitigating it

# Methods/Approaches

- Develop a new GHG measurement system to measure $CO_2$, $CH_4$, and $N_2O$ fluxes in situ, both vertically and laterally
- Measure GHG emissions and C stocks in order to understand how they respond to changes in (A) N loading, (B) climatic regimes (including temperature), and (C) sea level.
- Develop tools that coastal managers can use to apply that knowledge
- *Engage stakeholders from beginning and throughout to ensure project is responsive to their needs*.

Slide in part courtesy of Kroeger and Tang

# Fig. 1: Project Schematic




C – Carbon, N – Nitrogen, GHG – Greenhouse Gas
BGC – Biogeochemical
RAE – Restore Americas Estuaries

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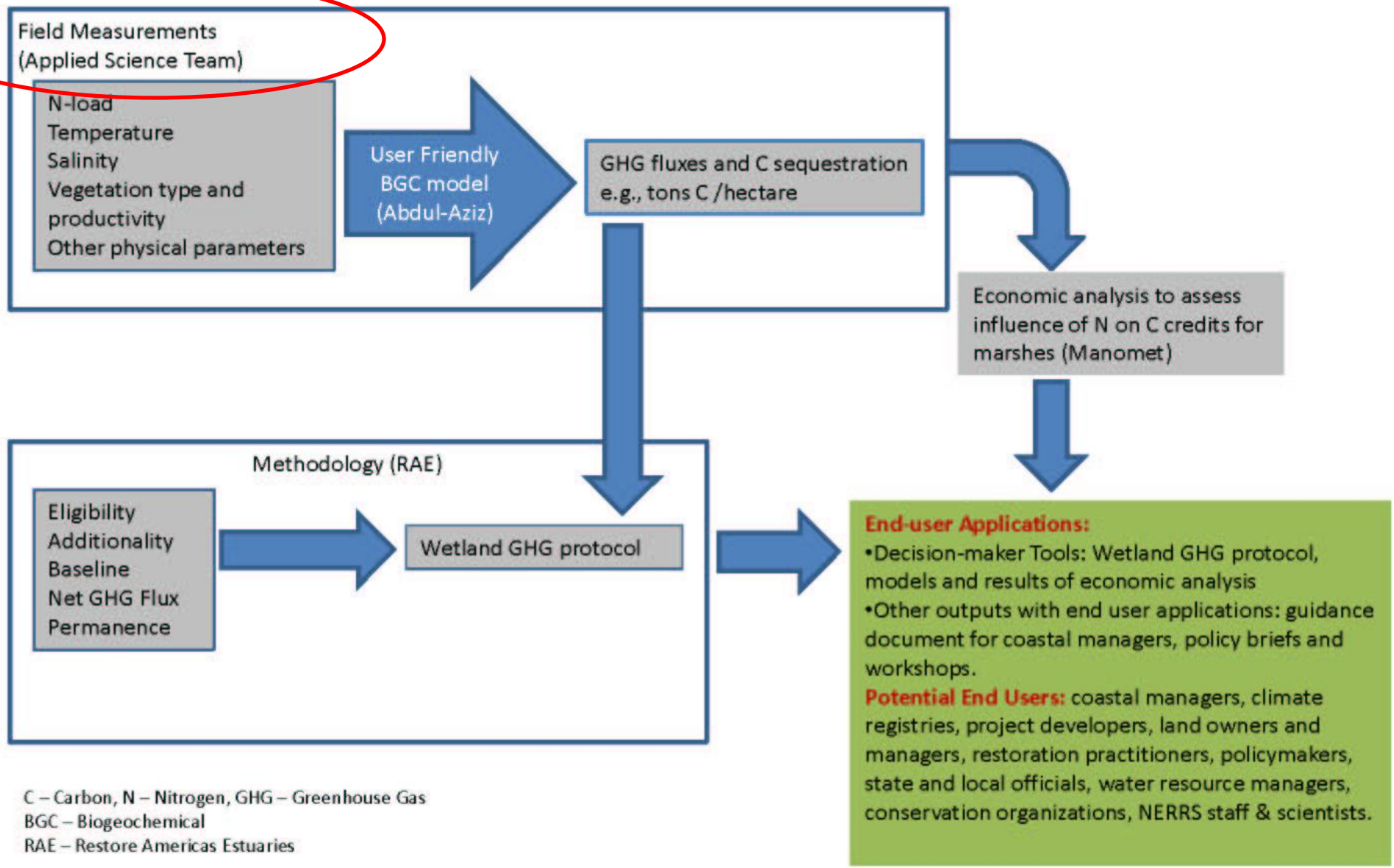


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# Conceptual framework (science piece)

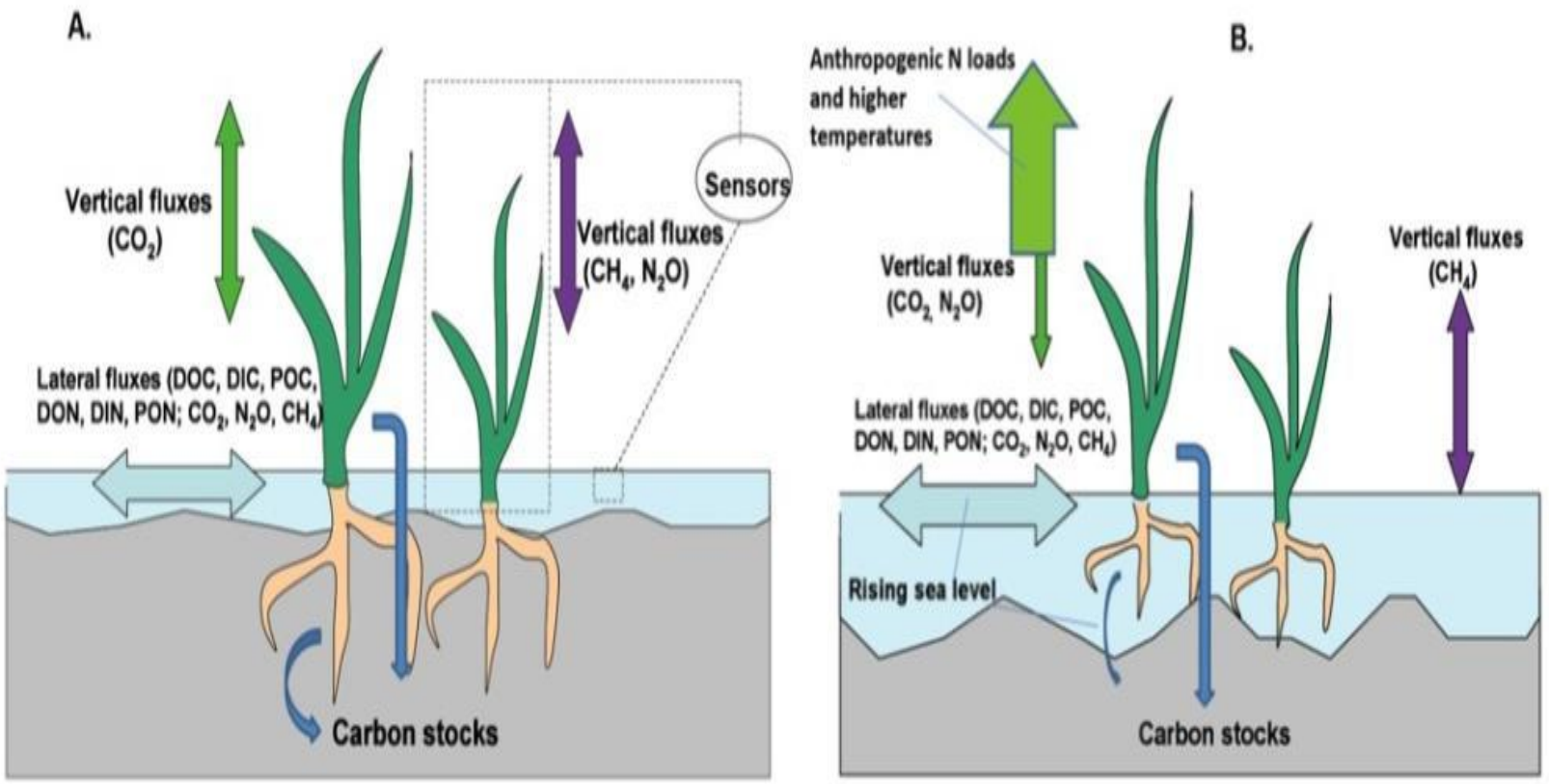


*Fig. 2A. Diagram of GHG emissions and C sequestration (C stocks) in coastal wetlands; the dotted lines indicate measurement of vertical and lateral fluxes with sensors. B. Simplified presentation of hypothesized changes in vertical and lateral fluxes of GHGs and declines in C stocks with N loading, temperature, and sea level. Only a few of the potential effects of these factors have been illustrated in this figure.*

Slide courtesy of Kevin Kroeger, Jim Tang

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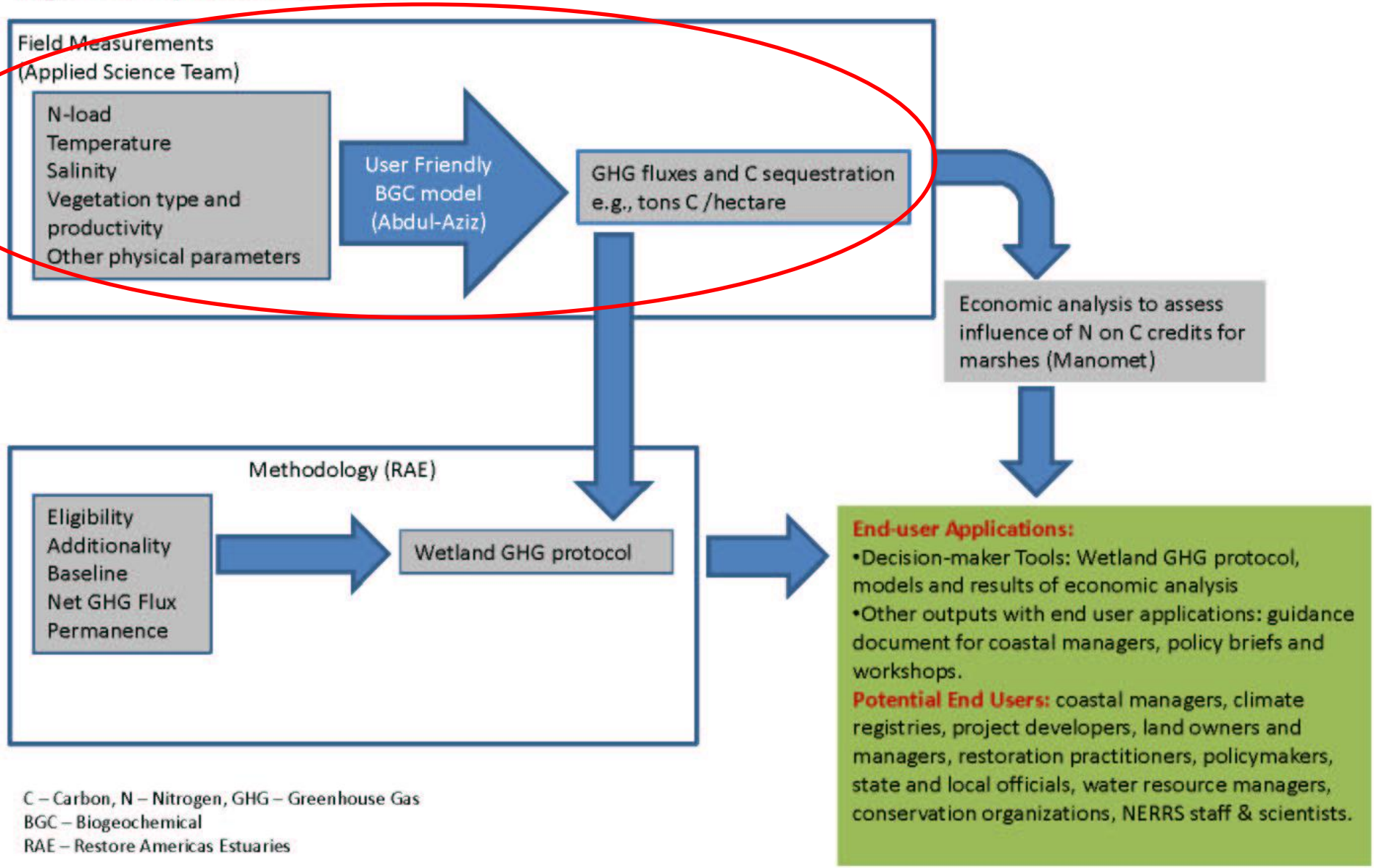


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# Model

- Identify similitude, formulate useful dimensionless numbers, and develop scaling (in terms of time, space, and processes) relationships for wetland $CO_2$, $CH_4$, and $N_2O$ emissions and C seq.

- Evaluate the dimensionless scaling relationships with observed data from diverse coastal wetlands.

- Apply similitudes and scaling to develop simple, user-friendly models for robust prediction of GHG emissions and C seq. from wetland ecosystems across a wide range of time (e.g., seasons) and space (e.g., region) scales.

**Slide courtesy of Omar Abdul-Aziz**

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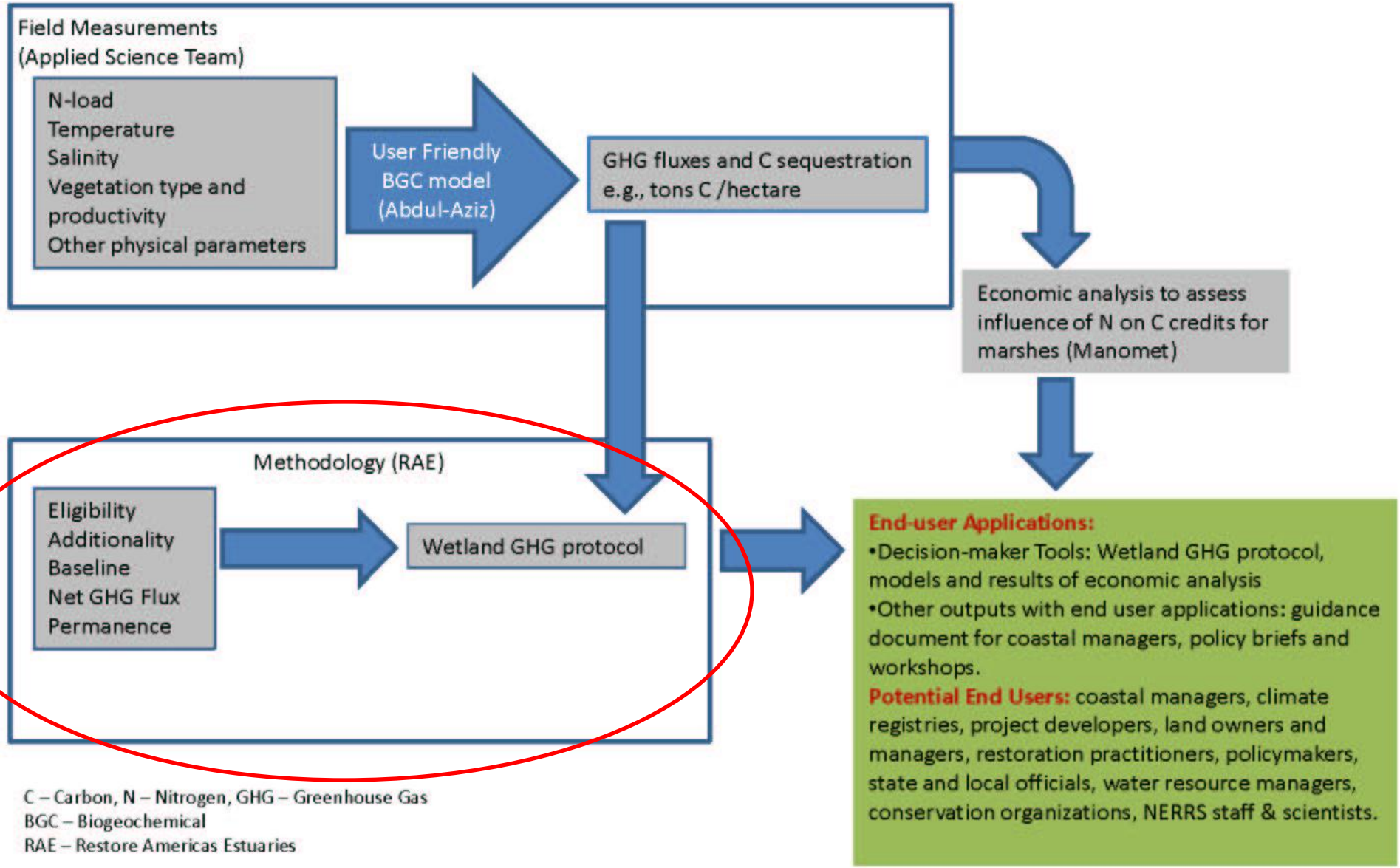


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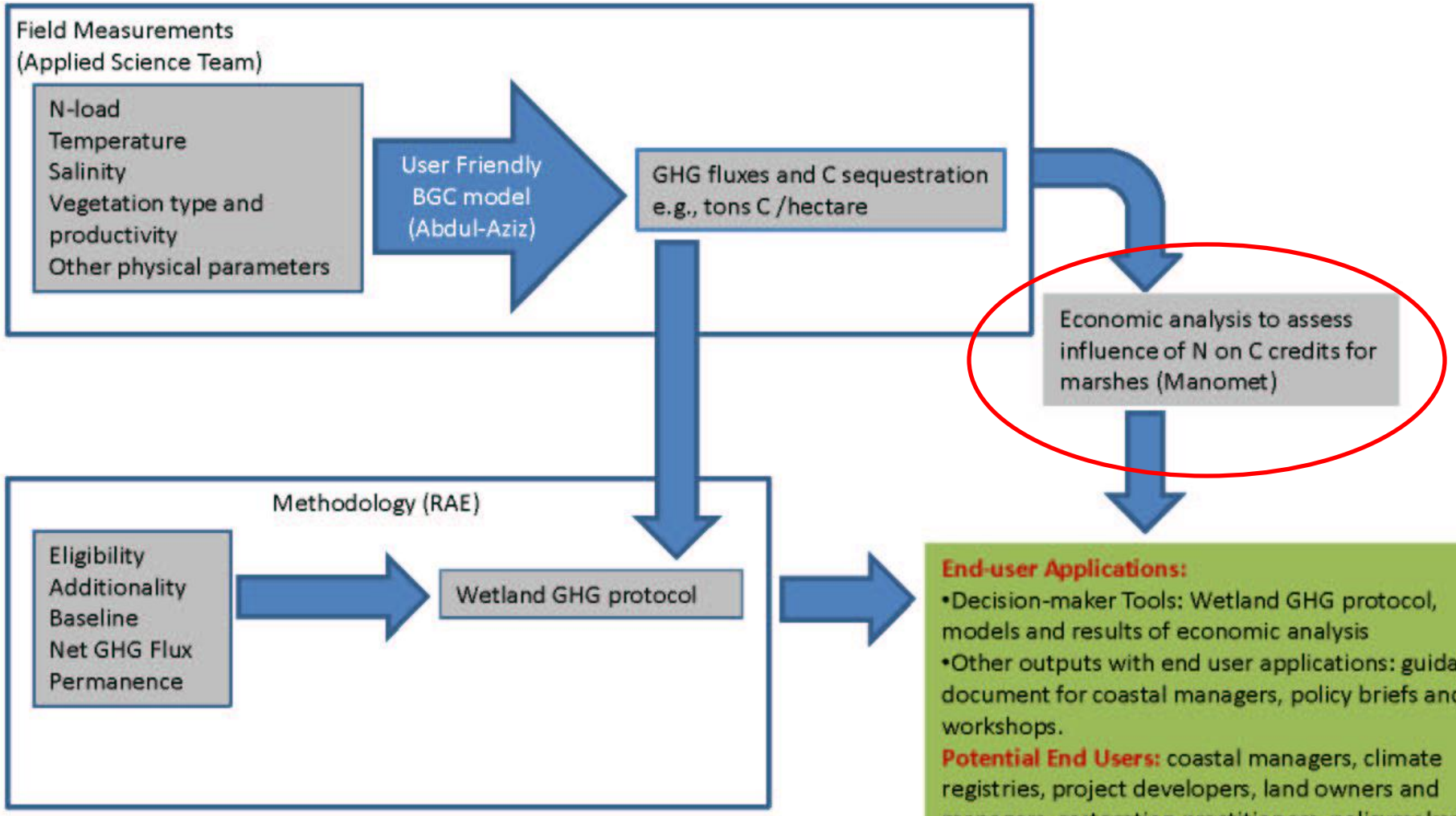


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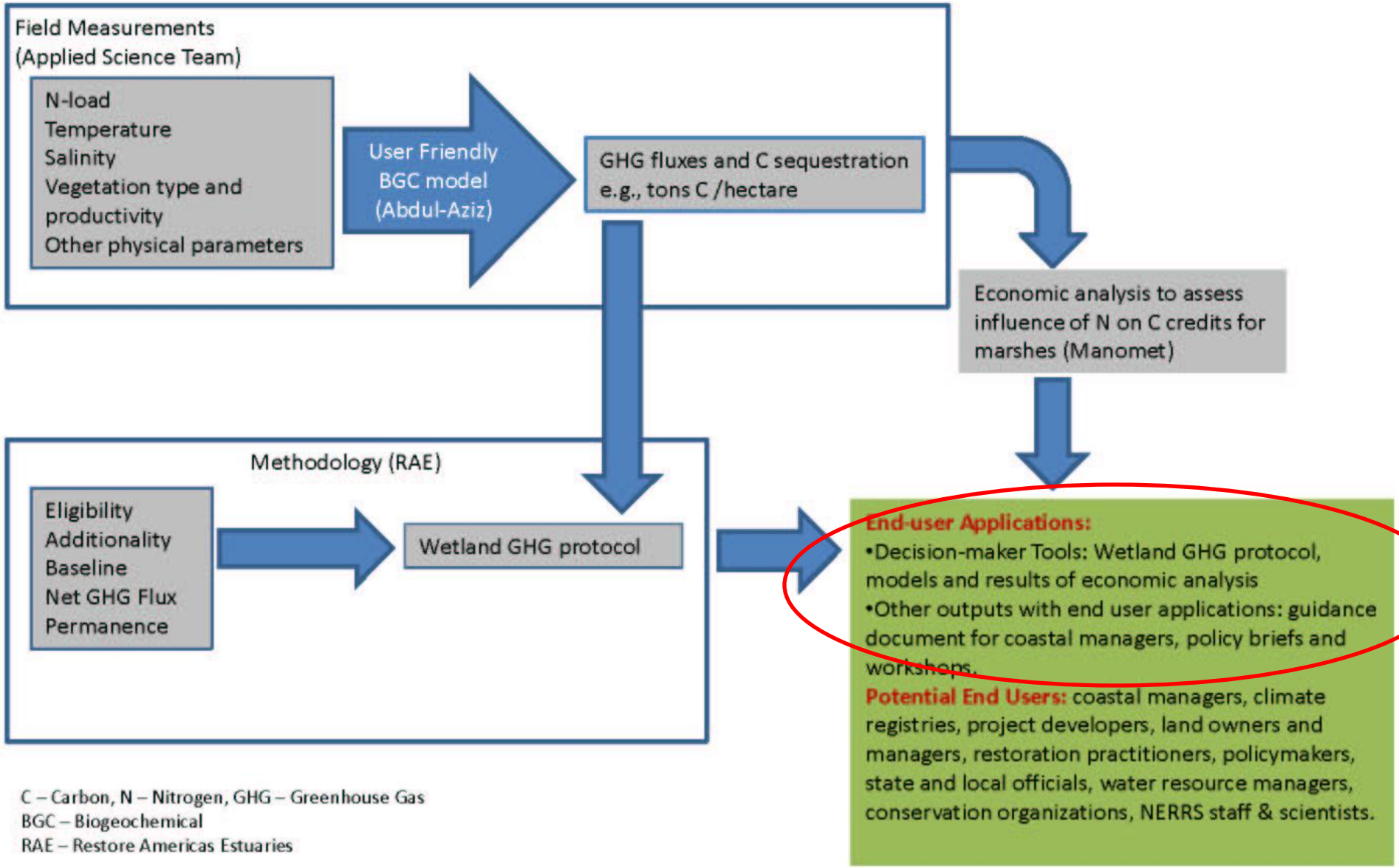


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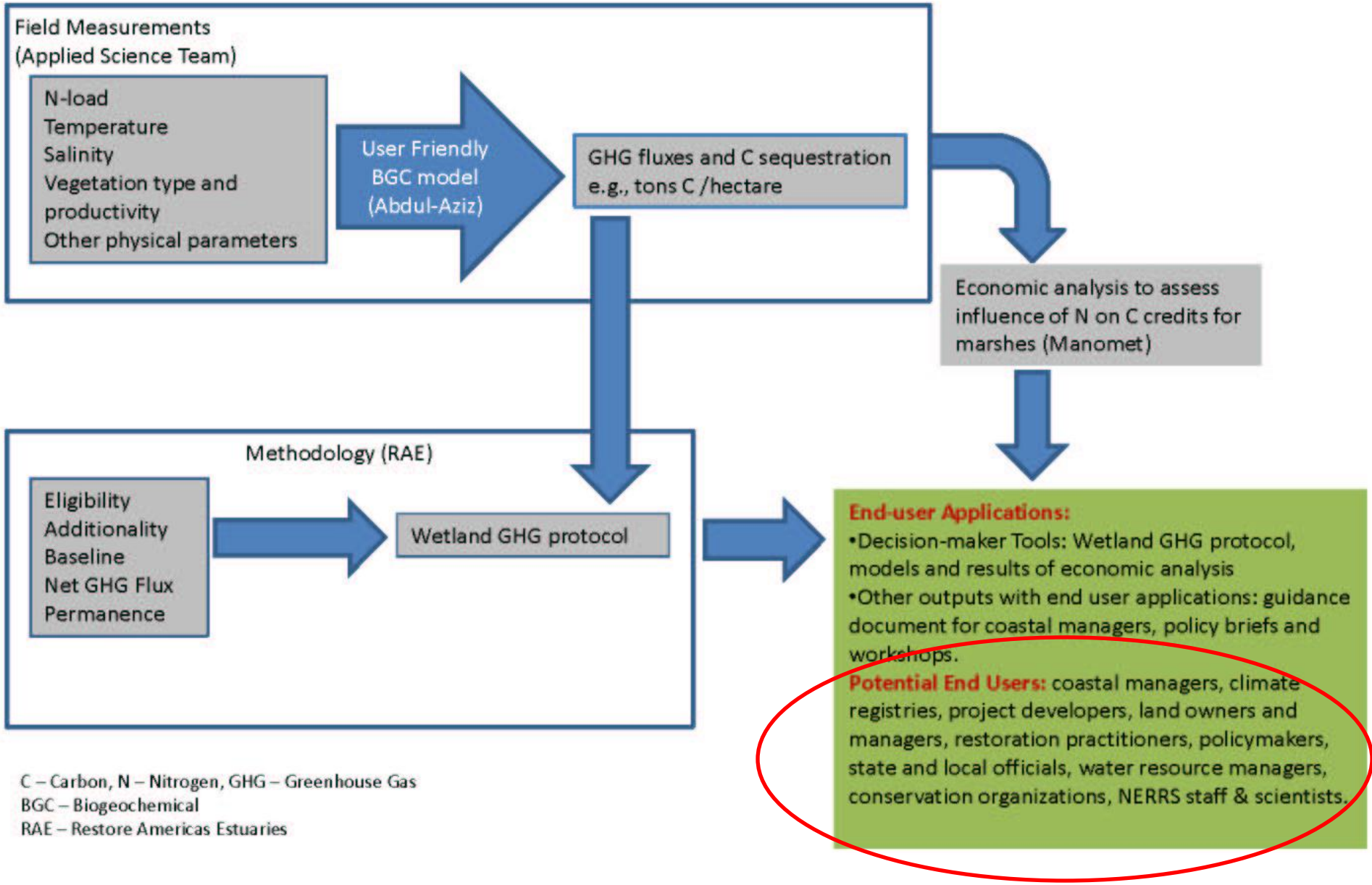


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# Two tiers of users

- RAE, Manomet, FIU use science to develop tools (involved in proposal)
  - Carbon offset methodology and guidance document for coastal wetlands
  - User-friendly model for estimating a project's GHG potential
  - Economic analysis of wetland restoration and development scenarios

- Local stakeholders use tools to answer questions like:
  - How many tons of carbon storage will a wetland development or restoration project provide?
  - How much is that worth in today's carbon market?
  - What is the impact of N on that tonnage or worth? Enough to fund N mitigation strategies?
  - Will CC change any of this?
  - How can I use this information as a "metric" to promote a restoration project or land purchase?
  - New policies around N or C or restoration?

# Who will we engage?

- Restoration community
- Coastal managers
- Climate registries
- Policy-makers
- Land owners
- State agencies addressing nitrogen loading and climate change mitigation and adaptation
- Local municipalities
- Project developers
- Conservation organizations
- NERRS
- Others?

# How?

- 2-day workshop using Collaborative Learning model
- Interviews before and after
- Other meetings, phone interviews
- WebEx's throughout project
- Conference at end to roll out model and protocol

# Collaborators:

- Waquoit Bay National Estuarine Research Reserve – Alison Leschen, Tonna-Marie Rogers, Chris Weidman, Jordan Mora, Jim Rassman
- National Estuarine Research Reserve Association
- USGS - Kevin Kroeger, Neil Ganju
- Marine Biological Laboratory - Jianwu (Jim) Tang,
- Univ. of Rhode Island - Serena Moseman-Valtierra
- Florida International University - Omar Abdul-Aziz,
- Manomet Center for Conservation Science -Tom Walker
- Restore America's Estuaries - Steve Emmett-Mattox, also Steve Crooks, Pat Megonigal, Igino Emmer
- Many local stakeholders